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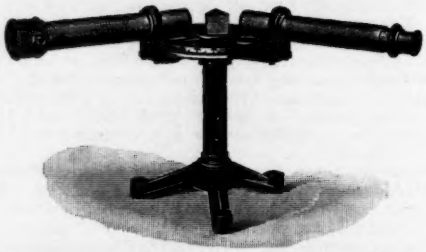

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UNIVERSITIES AND ACADEMIC FREEDOM

PROBABLY the most outstanding feature of university developments in Great Britain in the post-war years is the extent to which both old and new universities have become dependent on State assistance. Whereas in 1920–21 only some 33 per cent of their funds came directly from the Treasury and 12 per cent from local authorities, in 1953–54 no less than 70·5 per cent of their recurrent income came from Parliamentary grants, and 3·6 per cent from local authority grants. Moreover, the proportion of students holding scholarships or some form of award from public or private funds has risen from 45 per cent in 1928–29 to some 71·9 per cent in 1953–54, and these proportions are increasing. At the same time, over the past ten years the universities have drawn from the State practically all the funds for large-scale capital development, instead of, as previously, having to find such funds from endowments or through local effort. While the proportionate financial dependence of the universities on the State has thus increased, the share of the national resources which goes to the universities has also increased very greatly. In 1920–21 the income of the universities in Britain was about £3 million, but in 1953–54 it exceeded £31 million, and the expenditure per student averaged nearly £400 instead of about £75.

This growing dependence of the universities on the State is one reason for the recurrence of discussions on academic independence and autonomy at almost every gathering of university bodies, whether at the Conferences of the Home Universities, at the Congress of Universities of the Commonwealth, or at the Conference of the Universities of Western Europe held in Cambridge last July. Friendly observers from the United States at the Commonwealth Congress and in an earlier book, "Government Assistance to Universities in Great Britain" (see *Nature*, 171, 273; 1953), have openly expressed their doubts as to the universities of Britain being able to preserve their traditional independence. Notwithstanding the reassurances on this point given by successive Chancellors of the Exchequer, and the way in which the Treasury has hitherto consistently rejected proposals from the Committee on Public Accounts or the Select Committee on Estimates for methods of financial control which appear to endanger that autonomy, there is clearly apprehension on the subject within the universities themselves.

To such misgivings Sir Hector Hetherington gave frank expression in his P. J. Anderson Memorial Lecture to the University of Aberdeen last November*. Looking at the increasingly continuous and closer government and parliamentary intervention in university affairs, he displayed the reasons for this livelier interest and the agencies by which the present situation has been reached. Factually he concerned himself more particularly with the Scottish universities; but nevertheless his lecture is a most penetrating and critical survey of the British university system as a whole over the past forty years.

Sir Hector brings out at the start two interesting points. He does not expect government policy to achieve its declared objective of doubling the pre-war student numbers by about 1956, and suggests that the present increase of about 66 per cent may exaggerate the effective inflow of new students. The entry of graduating students, he notes, increased between 1938 and 1952 by only 55 per cent. Secondly, he notes that in Scotland, but not in England, there has been some quantitative shift away from the arts, and qualitatively too, as regards Glasgow, there is evidence that more of the abler students are studying science and medicine. The Scottish universities, drawing primarily on a home population of 10 per cent of that of Great Britain, contain 17·5 per cent of the university students, and while they contribute 13 per cent of all students in pure science, in medicine they provide 23 per cent, in technology 21 per cent, in agriculture 22 per cent, and in veterinary science 38 per cent. This response of the universities to the needs and challenges of a changed world has, he points out, been effected largely by the influence of government and public opinion, exercised, for example, through the royal commissions, of which at least six universities have been the subject in the past forty years, and the various committees, to which such names as Goodenough, Hankey, Barlow, Clapham, Scarborough, Teviot and Loveday are attached, that have surveyed different phases of university activity. Each university, moreover, is now normally closely in touch with half-a-dozen major Ministries, the needs and policies of which are reflected in its own work. Again, there are interrelationships with the Department of Scientific and Industrial Research and the research stations and research associations sponsored by that Department, as well as with the other research councils concerned with medicine and agriculture.

Sir Hector does not pursue in any detail the relations of universities to the national organization for research in pure and applied science. He recognizes that they form an essential part of that structure and while, from a passing reference to the Atomic Energy Authority, he is aware of the dangers of sponsored research or of such devices as the earmarked grant, he is content to leave their implications to be considered in the light of the general principles which he lays down. Prof. W. H. G. Armytage in his "Civic University"* has to some extent rectified this omission. In this connexion he refers pointedly to the extent to which the Advisory Council on Scientific Policy is concerned with university development from the point of view of scientific research as well as from that of education.

* The British University System 1914–1954. By Sir Hector Hetherington. (P. J. Anderson Memorial Lecture, 1954. Aberdeen University Studies, No. 33.) Pp. 13. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 1s.

* Civic University: Aspects of a British Tradition. By W. H. G. Armytage. Pp. 328+8 plates. (London: Ernest Benn, Ltd., 1955.) 30s. net.

Both Prof. Armytage and Sir Hector Hetherington, in reviewing the development of the University Grants Committee over its first twenty-five years, stress the revised terms of reference, which in 1946 placed on the Committee, besides the responsibility for advising on the financial needs of the universities and the distribution of the sums voted by Parliament, the functions of collecting and making available information about British universities and of assisting "in consultation with the universities and other bodies concerned the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs". Both again recognize that this implies the possibility of planned expansion under government rather than local initiative, and a definite move towards the development of a national system of university education. Both recognize that it was inevitable that this large responsibility should be laid upon the University Grants Committee, and that the time had come when the Government was bound to assure itself that somewhere in the university system provision was made for every field of learning which is necessary to the national interest. Nor do they suggest that this is not the right way to achieve that purpose.

Whereas, however, Prof. Armytage's analysis of the situation is concerned rather with the professional aspects and the ability of the universities to meet the needs of Britain for vocational education at that level and for research institutions, Sir Hector probes further into the working of the system, and emphasizes the special relation of the universities to the Treasury. With other Departments and organizations, the relations are those of collaborators, competitors or consumers in one or other form, and influence, though important, is indirect. With the Treasury, however, the relation is continuous, and, but for the intermediary University Grants Committee, direct. In so far as there is a Minister answerable in Parliament for the universities of Britain, it is neither the Minister of Education nor the Lord President of the Council but the Chancellor of the Exchequer; and by one of those curious touches of the British constitution, the Minister who watches most closely over the expenditure of other Ministers has in the universities a little spending department of his own, the autonomy of which he has in recent years stoutly defended in Parliament.

In discussing the implications of this situation, Prof. Armytage and Sir Hector are again complementary. The former, in considering the ways in which pressure may be brought to bear on the universities in the direction of vocational studies, sponsored research or the detailed control of expenditure, directs attention to certain intangible assets in the community which help the universities to resist such pressures. Against, for example, extreme calls for an externally imposed planned system of university education, the British universities can count on the fact that the limited size of the university population in the country greatly restricts the area of popular interest in the universities and the possible political pressures which could thus arise. This is reinforced by the fact that the universities are still severely professional, as can be seen in the persistent prejudices against the employment of university graduates in positions for which the changed educational pattern has greatly reduced the chances of recruiting the necessary talent in other ways. Still more potent is the sympathetic relationship between the universities, the University Grants Committee and the Treasury departments, which arises from the common outlook and origins of their personnel. That community of outlook and interests not only promotes co-operation but also an understanding that ensures that proposals which threaten to disturb the traditional autonomy of the universities will require to demonstrate a very clear public advantage if they are to pass the scrutiny even of the Government side.

Sir Hector takes this for granted. He examines rather the way British universities have drawn together—not so much deliberately in self-defence—for example, by joint consultation between an impressive range of specialist societies in which scholars and scientists take counsel about their several studies and the policies by which those studies may be advanced, or between less formal groups within and without the universities. He notes, too, the way in which circumstances have forced such a body as the Committee of Vice-Chancellors and Principals not merely to consider matters of common interest to the universities, but also to make commitments for the universities and to influence significantly university and even government policy; and he notes also the way in which university individualism is further circumscribed by external influences, even in regard to rates of pay.

Sir Hector is concerned rather to show how the Committee of Vice-Chancellors and Principals has come, somewhat against the wishes of its members, to function as it does as a body to the views of which both university courts and government departments attend with some care, notwithstanding that the Committee neither possesses nor desires executive authority. In his judgment something of the sort must have been created during the past twenty years if it had not already existed. But while he admits that, in this and in other ways, we have come a good deal nearer a university system, and that government influence is strong, Sir Hector gives no support to the idea canvassed during and since the War by, for example, the British Association Committee on Post-War University Education, the Parliamentary and Scientific Committee and the Association of University Teachers, for a fully representative Universities' Advisory Council. By implication rather than explicit statement, he suggests that the universities' defences are still sufficiently strong and that the existing organization provides effective means for formulating common policy where desirable, or on the other hand for representing common views to the Government.

Sir Hector's chief concern appears to be that British university structure may become too rigid in its internal and informal aspects, and that a certain consequential change of mood may be detrimental to the outlook and to the spirit of adventure in which

a university does its best work. A university is a living corporation or society—not an institution—the members of which are bound together to promote sound learning and the advancement of knowledge, to follow inquiry wherever it leads. If the growth of organization confuses that issue and leads to disregard of the freedoms essential for such a community or even to uncertainty as to their nature, university independence is endangered, no matter how carefully the Government itself may respect the right and duty of the university for final decision as to the organization of its courses and for the character and standards of the instruction given within its walls.

Sir Hector is not blind to the dangers of the present situation and trends. He recognizes that an unlucky appointment in any one of three or four key posts could easily work great mischief. He acknowledges that Parliament can rightly expect of the universities an account of their expenditure of the large sums of money they now receive, and that the universities should be ready to listen to criticisms of their activities. He recognizes, too, that this is an essential part of the task of building up an instructed public opinion and that, in the last resort, this is the only defence of the universities, though to him the pervasive influence of the mass mind seems to be a less formidable menace than it appeared to be to Sir Walter Moberly.

The next decade will show whether or not Sir Hector is too optimistic in this respect, but the evidence would suggest that the mass mind is a more formidable menace than when Sir Walter Moberly wrote six years or more ago, and that it would be unwise to rely unduly on the level of enlightenment in government circles. Indeed, there is already evidence of surrender on the part of the Ministry of Education to sectional pressures, and it could well be that the real threat to the full responsibility of the universities in academic affairs may in future come not from the Chancellor of the Exchequer or the Lord President of the Council, but from the Minister of Education, in spite of the absence of any formal responsibility on his part for the universities. Unless, indeed, educational policy as a whole is shaped with clear conceptions as to the purpose and functions of a university and of the over-riding importance of quality rather than numbers, decisions may be taken elsewhere which adversely affect the work of the universities or the resources at their disposal.

The education of public opinion as to the work of the universities and their essential place in the community thus involves much more than the purely factual accounting to Parliament or public opinion generally for the expenditure of the funds received from public sources. It means that the purpose and nature of a university should be widely and clearly understood, and also the way in which a university works and the vital relation of academic freedom to the achievement of its purposes and the service it renders to the community. It is not enough that this should be understood in government departments or in Parliament, though this is essential if plans for university expansion and for the development of technological or technical education are to be conceived soundly and kept in balance with national needs and resources. It means that, as Dr. Eric Ashby emphasized in a broadcast talk early this year on the British universities, a determined effort must be made to enlighten the man in the street, who is now the effective patron of the universities. The real threat to academic freedom is from public ignorance of what the universities are and what they are doing. The continuance of the effective functioning of the British university system depends in large measure on the extent to which the universities themselves and their alumni, whether in government office or department, in industry or in public or private life, seek and use every opportunity in Parliament, in the schools, in adult education and other extra-mural work and in every possible way to interpret to the public the purpose and method of university life and work.

BABYLONIAN ASTRONOMY

Astronomical Cuneiform Texts

Babylonian Ephemerides of the Seleucid Period for the Motion of the Sun, the Moon, and the Planets. Edited by O. Neugebauer. Vol. 1: Introduction, The Moon. Pp. xvi+278. Vol. 2: The Planets. Indices. Pp. xii+279–512. Vol. 3: Plates. Pp. v+255. (London: Percy Lund Humphries and Co., Ltd. Published for the Institute for Advanced Study, Princeton, New Jersey, U.S.A.) 105*s*. the set.

THE publication of these three volumes, containing the source material of our present knowledge of Babylonian astronomy, has placed all students of the history of mathematics and astronomy under a deep obligation to Prof. O. Neugebauer, whose earlier work, "The Exact Sciences in Antiquity" (1951), contains a brief summary (see *Nature*, 169, 854; 1952).

In the first of the two clearly marked periods in Babylonian science—the Old Babylonian, *c.* 1800–1600 B.C.—mathematics reached a high level, but astronomical knowledge was crude and merely qualitative. One group of documents contains the earliest records of actual observations in Mesopotamia. For several years the appearances and disappearances of the planet Venus were recorded, the dates being given in the contemporary lunar calendar, and have proved useful in determining the chronology of the Hammurapi period. Two texts dating from about 700 B.C., but undoubtedly based on older material, contain a summary of the astronomical knowledge of the day. One is concerned mainly with the fixed stars arranged in three 'roads', of which the middle one is an equatorial belt of about thirty degrees in width. The other deals with the Moon, the planets, the seasons, shadow-lengths and other related phenomena.

In the second period—the Seleucid—which is datable to the last three centuries B.C., the introduction of a sign for zero led to a complete mastery of arithmetical calculations immediately available for application to the problems of astronomy. The predominantly mathematical character of Babylonian astronomy was not realized by early investigators, who stressed the observational side and failed to appreciate the difficulties of observations near

the horizon in areas subject to desert sand-storms. It is a remarkable fact that not a single text of this period can be called wholly observational.

The most important step in the development of scientific astronomy was the adoption of the ecliptic (the apparent path of the Sun among the fixed stars in the course of the year) as a reference-line for all lunar and planetary phenomena—perhaps as early as 500 B.C. The calendar in use was essentially lunar. The day began in the evening (cf. *Genesis*, i, 13) and the month began on the evening of the day of first visibility of the new crescent Moon shortly after sunset. To predict this day accurately was the primary concern of the early astronomers, but the real problem for them was to fix the exact moment of conjunction of the Sun and Moon. The Babylonians solved it by considering the velocities of the Sun and Moon and their variations. How this scheme was evolved we do not know. We meet with it already fully developed in the "Ephemerides" and "Procedure Texts", more than three hundred of which have now been published in the volumes under consideration.

The "Ephemerides" are tables showing the position of the Sun, Moon and planets computed for regular time-intervals, comparable with those in our modern "Nautical Almanac", and used to predict the times of astronomical phenomena. Most of these tables were carefully written out in columns with details such as the date, the velocities of the Sun and Moon, and the various corrections required by the computer. On some tablets we find details frequently computed for several years in advance. The so-called "Procedure Texts" give rules for determining an ephemeris step by step. The tables are 'final copies', omitting intermediate steps in the calculations, and some of the columns give only the rounded-off values. These methods of computing lunar and planetary phenomena were certainly in use *c.* 250 B.C. Two slightly differing variants of the lunar theory were in use. One assumed the Sun to move with constant velocities on two complementary arcs of the ecliptic; the other assumed a linear zig-zag function for the Sun's velocity as a function of the time. The results are amazingly good and could scarcely be improved upon with elementary mathematics. The determination of eclipses was not so successful, since parallax of both the Sun and the Moon was completely disregarded. The Babylonian procedure shows a remarkably abstract attitude and unhesitatingly introduces quantities for purely mathematical convenience on the same principle as complex numbers are employed in modern mechanics.

Planetary theory was not developed to the same degree as that of the Moon. The method of time reckoning was independent of the civil calendar and was based on a special unit, the one-thirtieth of a lunar month, corresponding to the Hindu *tithi*. The use of this unit implies that the accuracy aimed at was less than that considered necessary in the case of the lunar theory. Several different systems were used, and interpolation schemes were ingeniously devised and skilfully applied to describe the daily motion of the planets.

We derive little of our knowledge of Babylonian astronomy from Greek sources. Pliny mentions the existence of astronomical schools at Uruk, Babylon and Sippar. Ptolemy refers to lists of eclipses dating back to 747 B.C. and complains of the lack in Babylonia of reliable planetary observations—a very fair estimate of the position.

Among units used, it is interesting to find the 'barleycorn' (the 1/180 part of a larger unit) used for the latitude. The degree was the fundamental unit for measurement of arc as it was for time. The day was divided into six parts, each divided again sexagesimally. This system was transferred to the sky and survives in our modern reckoning of right ascension and time. Water clocks were employed in connexion with measurements of the daily increase or decrease in the length of daylight or night.

The main incentive for the study of astronomy seems to have been the attempt to introduce some measure of regularity in the intercalations of the lunar calendar. Astronomy did not originate in astrology as has so often been stated; but the very widespread belief in astrology as the one science which gave insight into the causes of events on earth influenced the transmission of astronomical knowledge from one nation to another. The technique of Hellenistic astrology demanded knowledge of the position of the Sun, Moon and planets in the zodiacal signs at the moment under consideration, and this information was not immediately available from the Babylonian ephemerides, of which the elements played no part whatever in the practice of astrology. Magic, number-mysticism and astrology can no longer be regarded as the guiding forces in Babylonian science.

The texts considered in this new publication represent but a small fraction of the total available, most of which still remain unexamined. Few scholars are as competent as Prof. Neugebauer to deal with these, and perhaps in time he may be able to throw some light on the interesting problem of how the methods of computation were arrived at—quite possibly in a relatively short period, by some Newton or Einstein of the day. The three volumes are admirably printed, of handy size and include a full bibliography, a useful concordance of texts, glossaries and index.

R. W. Sloley

BIOLOGY IN SCHOOLS

The Teaching and Learning of Biology in Secondary Schools, with Special Reference to Grammar Schools

By Prof. L. T. Green. Second, revised edition. Pp. ix+248+6 plates. (London: Allman and Son (Publishers), Ltd., 1955.) 12*s.* 6*d.* net.

THIS new edition of Prof. L. T. Green's book is timely and useful. The author combines theory and practice in a skilful manner. Most books on science teaching neglect the problems of learning as distinct from those of teaching. There is a considerable bulk of research papers on science teaching, and these are relatively inaccessible to most teachers. There is, as Prof. Green remarks, a curious British tradition that objective techniques cannot be applied to educational problems. Nevertheless, he has made a careful digest of all such work relevant to his book, and the documentation is complete.

Prof. Green writes that the two generally accepted points in biology teaching are: first, that the study of biological science in schools should present a picture of biology as a whole and not consist of two quite separate courses of botany and zoology; secondly, that biology should be studied in terms of its general principles and functional aspects. Gener-

ally speaking, the universities do not know biology as a subject and maintain a rigid distinction between its several divisions. This has influenced the work of grammar schools and in general has rendered general science courses in schools an unsafe preparation for the university award and entrance examinations.

Prof. Green is an enthusiastic and efficient photographer, and this is reflected in his book. Every useful method of producing visual material, including models and their use in the work of teaching, is dealt with in a thorough and practical manner.

The author has examined the whole field, and while he makes a plea for a wider public attention to the problems of human biology, particularly in relation to population changes and family life, he is prepared to show how the best can be got from the more formal botany and zoology. There are chapters on museums and gardens, agricultural and economic botany, sylviculture, ecology, dissection, evolution, physiology and sex education.

The recent British Association report, "Biological Sciences in British Schools", is an important and realistic but rather depressing document. It stresses "the alarming deterioration in Biology teaching in schools". There are difficulties due to large classes, lack of laboratory assistance and teachers inadequate both in numbers and qualifications. There is also the widespread neglect of field-work at all levels in many schools. The teacher must have an interest in, and knowledge of, natural history and an ecological approach to the subject. Good biology teaching and, indeed, good science teaching in all its branches, are more than ever necessary at the present time; and the pressing problems concerning the provision of adequate human and material facilities for this work must be a first priority in national schemes, not only in education but in the field of economics also.

The book is not only a safe guide for the young teacher but will, in addition, stimulate and encourage the practised worker. It is a very valuable contribution to a subject of primary importance.

W. L. Sumner

THE GREAT BARRIER REEF

The Romance of the Great Barrier Reef

By Frank Reid. Pp. xiii + 191. (Sydney and London: Angus and Robertson, Ltd., 1954.) 18*s*.

ANYONE interested in Australia will be glad to have this book, especially if, like the reviewer, he knows the Barrier Reef waters. It is not in any sense a scientific work—and for that reason may be somewhat out of the ordinary run of books noted in *Nature*. It consists of twenty-six chapters of murder, piracy, cannibalism, escapes, 'blackbirding', wrecks, storms, and everything that goes to make the successful adventure book. The difference is that all these incidents are vouched for, and the sum total of frightfulness is far worse than any ordinary tale. It is, indeed, an example of fact being stranger than fiction.

Frank Reid is well known in Australia and he has collected the material in this book very largely from people who took part in the adventures, or were at any rate very closely concerned with them. The earlier events are based on historical records, and A. W. L. Russell, who was for some years honorary secretary of the Queensland Royal Geographical Society, states in his foreword, and the author in his preface, that all the events related, fantastic though some of them may be, are entirely factual. Many of them relate to the islands in Torres Straits—one of the most dangerous pieces of water in the world. Several others are based on the Palm Islands—now a large native reserve.

Apart from man's brutality, the book does bring out very clearly indeed the dangers of navigation in reef waters. Great care is always necessary, and it is difficult now to appreciate the dangers that Cook and his successors overcame in vessels which were entirely dependent upon wind and current. Anyone who has been to Lizard Island and seen the line of the outer barrier, the passes, the breakers, and the innumerable inner reefs gains a far greater respect for those who sailed the sea before the advent of power than can possibly be obtained from reading, however vivid the accounts may be.

To all who now travel in these waters, and especially to those who visit them in good weather for a holiday, I would recommend this book. Those who sail regularly in these waters, and those who have worked there scientifically and otherwise, will want to read it. I think one or two chapters might be added to a further edition to include the scientific 'romance' of the reefs. While it may be commended to all, I cannot but think its title should have been "The Tragedy of the Great Barrier Reef".

J. A. Steers

MECHANICAL PROPERTIES OF METALS

Strength and Resistance of Metals

By Prof. John M. Lessells. Pp. xiv + 450. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 80*s*. net.

THIS book, which is primarily directed to engineers, covers that field, within the purlieus of engineering and metallurgy, concerned with the resistance of metals to deformation and fracture. Here, the theory of elasticity, which frequently masquerades under the misnomer 'strength of materials', has a limited application, and considerations of plasticity and fracture are essential for a complete description of the behaviour which is observed in practice. The tenuous understanding of these factors at the turn of the century precipitated an experimental approach in which such properties as hardness and notched-bar value were measured to assess the suitability of a metal for a particular engineering application. In this development little regard was paid to the real meaning of the tests; but the metallurgical engineer to-day feels that information of fundamental significance is implicit in the copious legacy of these mechanical test results which have been handed down to him. This suspicion receives support from recent progress in the understanding of plastic flow and fracture, and the time is now ripe to incorporate some of these ideas in text-books on 'mechanical testing', which too often concern themselves almost exclusively with standardized testing procedure and results. Although the efforts of the author of the book under review are a welcome step in this direction, it must be admitted that he could have availed himself more fully of the opportunity to fill this palpable gap in the literature.

The observational features of tensile, hardness, notched bar, wear, hysteresis and fatigue testing are well presented, with a text liberally garnished with tables of typical results by way of illustration. Fatigue, which is clearly close to the author's heart, receives a particularly generous coverage. A commendable feature is a chapter on the effects of overstrain in the early part of the tensile stress – strain curve, which, although known for at least fifty years, seldom finds its way into books of this kind. A realistic preference for proof stress rather than elastic limit permeates the text, along with a recognition of the importance of hysteresis. Those interested to learn more about the neglected factor of spurious energy loss in notched-bar testing, to which the author properly directs attention, would do well to consult reference 1, which is given on p. 287 for a different purpose.

The substantial section devoted to engineering resilience calculations, in the chapter on impact tests, appears a little out of place in this work, and the inclusion of notched-bar tests under the same general heading is misleading in view of the secondary importance of the rate of deformation here. In the interspersed sections of the text on interpretation of the tests, the author does not always get completely to grips with the problems. For example, no mention is made of Tabor's illuminating, but admittedly approximate, application of plane strain plasticity to the analysis of the hardness test; and the treatment of the yield point in iron and its associated recovery from overstrain would make more convincing reading if related to Cottrell's basically simple picture of solute atom migration.

Briefly, the book, which is handsomely printed and illustrated, gives a competent account of the experimental features of the mechanical properties of metals, but the senior and graduate student to whom the work is commended in the preface will probably find its attempts at interpretation inadequately stimulating.

K. M. Entwistle

GEOLOGY OF THE ICE AGE

Das Eiszeitalter

Grundlinien einer Geologie des Quartärs. Von Dr. Paul Woldstedt. Erster Band: Die Allgemeinen Erscheinungen des Eiszeitalters. Zweite, völlig neu bearbeitete Auflage. Pp. vii + 374. (Stuttgart: Ferdinand Enke Verlag, 1954.) 41 D. marks.

THE study of Pleistocene deposits is often more difficult than that of some older rocks because of the diversity of facies which is found. In dating Pleistocene beds it is therefore safer, where possible, to rely on more than one kind of 'zonal fossil'. In the present volume, as in past work, Prof. P. Woldstedt has proved himself to be a believer in this principle and shows an admirable all-round approach to the problems of the Ice Age. I understand from a statement at the end of the first chapter that this is only the first volume of a more comprehensive work and that a second is to be written dealing with separate regions.

After one introductory chapter, Chapters 2–9 are devoted to comparative glaciology: a full description is given of the world's existing ice-sheets, and depositional forms, including various kinds of moraines, outwash gravels and loess, as well as the processes of erosion, are discussed as effects of the Pleistocene ice-sheets. Interesting details are also given of the work by Milthers and others on the erratics carried by the various Baltic glaciers. The author's treatment of these subjects is in harmony with his long experience in the field, and the illustrations, some of which are exceptionally clear, are partly from his own photographs.

Prof. Woldstedt then turns his attention to fossil plants and animals, dealing at some length with the interglacial plant beds (Chapter 12) and tracing the evolution of the flora through the succession from the Reuverian up to the Holocene. Pollen diagrams are shown for the Cromer Forest Bed, which is considered to be Pre-Elster, also for the Elster–Saale and Last Interglacials in Northern and Central Europe, with detailed descriptions of the forest histories. No attention is paid to the plant remains at Hoxne, but now that this site has been freshly described by West and Donner, presumably it will be included in the forthcoming second volume. Examples are also given (Chapter 10) of marine interglacial deposits. The Eem marine beds of Holland and Germany are placed in the Last Interglacial, and the earlier Holstein deposits in the Elster–Saale Interglacial; and in Table 1, p. 215, the Holstein horizon is correlated with the Tyrrhenian, and the Eem with the Monastirian. This table summarizes the author's ideas on long-distance correlations and emphasizes a major problem which has been evident in his earlier publications, namely, the difficulty of fitting in the three known glaciations of Northern Germany with the four (or five) recognized elsewhere.

Chapters 13 and 14 then summarize the kinds of fossil man and his implements, maintaining that the Heidelberg jaw and the earliest *Pithecanthropus* remains belong to the Gunz-Mindel Interglacial, and Peking man is placed with the Swanscombe and Steinheim fossils in the Mindel-Riss stage. The Fontéchevade and Ehringsdorf remains are placed with the Neanderthal man in the Last Interglacial. Dating of the Palæolithic implements is conventionally related to the Alpine glacial sequence.

The last three chapters (15–17) are given up to the problems of isostatic and eustatic changes of level, to a discussion of changes of climate and finally to a summary of the theories which have been formed to account for these changes. The theoretical aspect of these questions is sometimes overstressed, as in the discussion of eustatic changes of sea-level, and Fig. 121 on p. 294 represents these changes according to an ideal which does not entirely agree with the facts discovered by Gignoux, Deperet and later workers; for example, the Sicilian stage is placed in an interglacial episode in spite of the fact that it has a notably cold fauna. Apart from some of these details, most interesting climatic reconstructions are attempted, one of the most successful showing the position of the ice-sheets, tree-line and temperate forests during the Last Glaciation (Fig. 129, p. 320). The discussion of the causes of climatic change is very detailed.

The list of references at the end is comprehensive, considering the complexity of the subject, but certain omissions will perhaps be put right in the next volume; the main work of James Geikie, F. W. Harmer and Prof. P. G. H. Boswell, for example, receives little or no attention. In general, however, this book is particularly well indexed and is a most useful and well-balanced introduction to a very intricate subject.

D. F. W. Baden-Powell

Thunderstorm Electricity

Edited by Horace R. Byers. Pp. viii+344. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 45*s*. net.

THE volume under review is a compendium based on contributions to a conference held in Chicago in 1950, some of which have been brought up to date, together with a few chapters from other workers. The chapters deal in turn with general results of atmospheric electricity, thunderstorm dynamics, cloud physics and charge generation, followed by chapters dealing more directly with thunderstorm electricity and finishing with lightning and its effects on aircraft and power lines. As a collection of separate contributions, the book naturally suffers from a lack of coherence, and as a volume on "Thunderstorm Electricity" it may be criticized in that a great many of the chapters are not directly connected with that subject, but contain background information; for example, in the longest chapter, Chapter 5, by H. Weickmann, a mere three pages out of seventy-three are concerned with electrical phenomena.

But every chapter is of considerable interest to those whose work is at all connected with thunderstorms, though the chapters themselves are uneven in content: for example, Chapter 3, by L. Koenigsfeld, describes new work, perhaps more suitable for publication in a journal than in such a volume; Chapter 8, by R. Gunn, is a useful summary of his previously published work; and Chapter 14, by H. Norinder, combines a historical survey with an account of recent work.

The volume is attractively produced, and the large numbers of diagrams and plates are very clear. The nature of the volume has made cross-references impossible, but an index would have greatly added to its value. J. Alan Chalmers

Infinite Abelian Groups

By Irving Kaplansky. (University of Michigan Publications in Mathematics—No. 2.) Pp. v+91. (Ann Arbor: University of Michigan Press; London: Oxford University Press, 1954.) 16*s*. net.

A REMARKABLE amount of material has been compressed into this monograph. After some examples of Abelian groups, definitions follow, together with some properties, of torsion groups and divisible groups. Then pure subgroups (*Servanzuntergruppe*) and groups of bounded order are studied, and the important notion of height is introduced. This leads up to Ulm's theorem, which, involving both cardinal and ordinal numbers, gives a complete classification of countable torsion groups. The next part is concerned with the extension of preceding results to modules over principal ideal rings and an application to the theory of linear transformations. Then the ring is restricted to a discrete valuation ring R, and a study is made of a complete R-module (that is, complete in its p-adic topology). A partial classification of the submodules of a given module is made in terms of the characteristic submodules, and the account ends with a review of recent literature.

The material presented is part of a course of lectures given in 1950 in the University of Chicago. Prof. I. Kaplansky has a crisp, vivid style, and a pleasant feature is the interruption of the text at various points to ask a pertinent question such as "What is our goal in studying Abelian groups?", or "How do we know when we have a satisfactory theorem?". The general atmosphere of the book is one of freshness and vigour, and the reader has the satisfaction of knowing that he is being led right up to the edge of our knowledge of a branch of modern infinite algebra. L. S. Goddard

Applied X-rays

By Prof. George L. Clark. Fourth edition. (International Series in Pure and Applied Physics.) Pp. ix+843. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 89*s*. 6*d*.

THE previous edition of this book—one of the McGraw-Hill International Series—was published thirteen years ago. In that time a great deal of development has taken place in the application of X-rays to almost all branches of science, and the attempt to cover all these applications has produced a work that is generally unsatisfactory.

It must now be accepted that the subject of X-rays and their applications is too large to be covered by a single text-book, and the present book can only be regarded as a rather poor patchwork; it covers instrumentation, radiography, biological applications, X-ray diffraction and crystal chemistry. The author seems at his best in the earlier sections, the later sections being much too condensed and not distinguished by any originality of the point of view.

The presentation of much of the material seems hurried and careless. Several tables are reproduced from other works, sometimes without adequate explanation, sometimes with mistakes, and sometimes without acknowledgment. There are numerous mis-spellings of names in the references, and there is no author index. Altogether, the book must be regarded as a rather unworthy companion to the other members of this important series. Finally, I would like to ask why, in general, American books are printed on such heavy paper; this one weighs 3 lb. and is most uncomfortable to handle for prolonged periods. H. Lipson

Organic Syntheses—Collective Volume 3

Edited by E. C. Horning. (A Revised edition of Annual Volumes 20–29.) Pp. x+890. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 120*s*. net.

THIS work, begun as an annual publication in 1921 under the original editorship of Prof. Roger Adams, has proved from the first to be a practical aid of very high value to students and research workers in organic chemistry and biochemistry. It is a thoroughly reliable, accurate and comprehensive *vade mecum* for all who are actively engaged in these great and expanding fields of science. It was a happy thought of the editors to issue a collective volume at intervals, and the third volume of this kind includes the classified and revised material of annual Vols. 20–29.

In all, particulars are here given for the preparation of more than three hundred and fifty organic compounds and reagents, and there are details of new procedures for acenaphthenequinone, aminoacetal, α-tetralone, and several other substances. References have been brought up to date and linked with *Chemical Abstracts* in order to facilitate a complete search of the literature. The vast amount of material in the book has been made readily accessible by means of indexes of reactions, types of compounds, formulæ, solvents and reagents, and illustrations, in addition to a comprehensive general index. Altogether, this collective volume, like its two predecessors, is a time-saver of the first order. John Read

PEACEFUL USES OF ATOMIC ENERGY

CHEMICAL, METALLURGICAL AND GENERAL TECHNOLOGICAL SESSIONS AT GENEVA

By Dr. R. SPENCE, C.B.

THE economic aspects and engineering design of nuclear power reactors naturally provided the main theme for the recent Conference on the Peaceful Uses of Atomic Energy held in Geneva; the supporting sciences and technologies were, however, adequately represented in parallel sessions which commenced on August 11 and finished on August 20. The *A* Sessions were mainly devoted to physics and reactor engineering; raw materials, chemistry, chemical technology, metallurgy and waste disposal problems were discussed in the *B* Sessions, while the *C* Sessions were concerned with medical and biological problems and with applications of radioisotopes.

Until quite recently, it would not have been possible to hold useful international discussions on some of these topics, but the situation has changed so rapidly during the past few months that the United States, Great Britain and Canada have been able to release a very substantial amount of technical information. The complete success of the Conference was assured when it also became known that there would be important contributions from the U.S.S.R. Undoubtedly, the greatest mass of information, in practically all fields, was supplied by the United States, and many very comprehensive survey papers were included. There were about as many Russian contributions as British, but they were not so evenly spread; for example, there were no Russian papers on chemical processing or on waste disposal. Contributions from other nations were sufficiently numerous and sufficiently important to give the Conference a truly international flavour.

One of the most valuable papers in the *B* Sessions, and perhaps one of the most important in the whole Conference, was that given by Mr. Jesse Johnson, head of the Raw Materials Division of the U.S. Atomic Energy Commission. He estimated that at least one million tons of uranium can be extracted at a reasonable price and that much more is obtainable. This means that there will be no shortage of uranium even for substantial natural uranium power schemes such as that recently announced by Great Britain. In the Russian exhibit there was a particularly fine display of uranium minerals, and the paper by H. Sankhoff on location of ore bodies by radiochemical analysis of ground waters was specially interesting, as no other country appears to have used this method systematically.

There were very detailed American papers on the production of heavy water, on the production of the atomic energy metals and on graphite, together with important contributions from Britain, Canada, France and the U.S.S.R. These papers, and the discussions which followed them, will allow those countries which hope to initiate an atomic energy programme of their own to make an appreciation of the feasibility of producing some of the necessary materials themselves. It was made clear in some of the economic discussions in the plenary sessions that the factors which the so-called under-developed countries would take into consideration in making their appreciations might be quite different from those ruling in the case of the technically advanced countries. Countries with local supplies of one or other of the necessary raw materials may not be deterred by purely economic considerations, therefore, from setting up their own factories or refineries.

The situation as regards the chemical processing of irradiated reactor fuel seems to be rather different. In spite of the fact that the chemical processing plant is an essential component in the industrial atomic power complex, and that the information released at the Conference was exceptionally complete, the discussion in the sessions dealing with this subject was restricted to the specialists, mainly those coming from the United States and Britain. This may have been due to the fact that the processing sessions were held on the penultimate day of the Conference, by which time delegates were visibly tiring; but it was more probably due to a general acceptance of the likelihood that such plants will have to be designed, built and perhaps operated by organizations within the technically advanced countries.

The sessions on waste disposal were most instructive, although here again the bulk of the information was provided by the United States and Britain. It was particularly interesting to hear an account of the elaborate storage system for highly active liquors which has been installed at the great Hanford works in the United States. Several speakers emphasized that the scale and cost of the highly active storage and disposal facilities are very greatly dependent on the nature of the reactor and chemical plant with which these facilities are associated. On the other hand, it was admitted that even some of the more elaborate systems would add only a small percentage to the cost of power generated. The real problem is the danger and embarrassment which would arise if there should be any accidental spread of these highly active liquids. There seemed to be general agreement on the policy to be adopted in a nuclear power scheme, namely, concentration, separation of cæsium-137 and strontium-90 and storage of the less dangerous residue for ten to fifteen years with ultimate burial or discharge to sea, perhaps after extracting some of the more useful isotopes.

In contrast to the chemical processing and waste disposal sessions, there were notable Russian contributions in those sessions dealing with laboratory facilities for handling highly radioactive materials and with the effects of radiation on materials. While nothing was disclosed which was outstandingly new, it was evident that the Russian laboratories are well equipped in this respect and that much useful work is going on there. Similarly, in the fields of inorganic chemistry and radiochemistry and in analytical chemistry, it was quite evident that Russian scientists are well advanced. They reported, for example, interesting work on elements such as ruthenium, americium and technetium, and a new application of the isotope dilution technique to the emission spectroscopic method of isotopic analysis. Very fine review papers were presented in most of these sessions by American authors and there were also

certain outstanding contributions from the United Kingdom, notably the paper on the chemistry of ruthenium, which was far in advance of any other work on this element reported at the Conference. The Barker square-wave polarograph, which was shown in the United Kingdom exhibit at the Palais des Nations, also attracted considerable attention from analytical chemists as a new and original instrument of great potentiality.

The two exhibitions, one in the Palais des Nations and the other in the Salle des Expositions in Geneva, were both extremely good. The United Kingdom sections in particular received universal praise, which the hard-working organizers thoroughly deserved.

For chemists and metallurgists as well as for engineers and physicists, the Conference was a tremendous success. To discuss matters which have been kept secret for so long, in the free atmosphere of an international conference, was an exhilarating experience, and to establish personal connexions with other scientists who have been working in the same field was extraordinarily beneficial. Possibly after more sober appraisal, it may be found that the value of the Conference to the United States, Canada and Great Britain lies mainly in such intangible benefits as those just mentioned; but there can be no doubt that for the world at large the gain was a great one.

GOUGH ISLAND SCIENTIFIC SURVEY

By J. B. HEANEY
Organizer

AN eight-man expedition, most of whose members are graduates of Oxford or Cambridge, left the United Kingdom at the end of August to carry out a six-month scientific exploration of Gough Island. The island is one of the few high peaks of the Mid-Atlantic Ridge that pierce the ocean surface, and lies some 260 miles south-south-east of the three islands of the Tristan da Cunha group; it is a remote outpost of the Commonwealth, 1,500 miles from the Cape of Good Hope, and in the path of the 'Roaring Forties', which, by all accounts, give it an unfriendly climate with frequent ferocious storms and often cold, damp and foggy weather.

The conception and organization of the Gough Island Scientific Survey were mine, but, due to medical advice, I cannot take part in the field-work, and the leadership of the party has been handed over to Mr. Robert Chambers. The expedition is actively supported by the Royal Geographical Society, the Scott Polar Research Institute, the Mount Everest Foundation, and many other bodies and scientific institutions in Great Britain.

Uninhabited by man, Gough Island is a precipitous mass of volcanic rock rising to nearly 3,000 ft.; it measures about eight miles by four, and from its western storm-beaten beaches cliffs tower to 1,000 ft. Mountaineering techniques will be employed to enable the party to travel freely over the area.

The island has been described as a 'naturalist's paradise'; and is the only remaining sub-antarctic island which has not been thoroughly investigated. It has a luscious vegetation of small stunted trees, tree-ferns, tussock grass and mosses, and a rich bird life. It is the home of a unique species of flightless rail which has lost the use of its wings through processes of natural selection; some of the insects will probably show the same degeneration. Large numbers of albatrosses and rockhopper penguins nest on Gough Island, and every year an increasing number of fur seals and elephant seals haul out to breed on the beaches. These animals were exterminated from the island by the depredations of the sealers during the past century, and since their exploitation became unprofitable the island has been visited on very few occasions. In 1904 the expedition ship *Scotia* called, homeward bound from the Antarctic, and small collections were made on the island on one day, and again in 1922 members of Shackleton's last expedition from the *Quest* spent four days ashore. Present knowledge of the island's geology and natural history is chiefly based on collections made on these two occasions, and also on those made by a Norwegian who spent a few hours ashore in 1934. That a detailed scientific investigation of Gough Island is eminently worth while is indicated in an article by Prof. R. N. Rudmose Brown, of the *Scotia's* party, when he wrote, "No doubt looked at from an impartial standpoint, Gough Island is but a relatively insignificant rock in mid-ocean, but its very isolation makes it of great interest. It may throw light on some former continuity of land in the Southern Hemisphere, and it cannot fail to elucidate various problems of biological distribution when its fauna and flora have been thoroughly investigated. It is for these reasons that its further exploration is so much to be desired".

The members of the expedition, with the qualifications and ages, are listed below: R. J. H. Chambers (leader, surveyor), 23; J. P. Hall (cameraman), 32; M. W. Holdgate (zoologist), 24; R. W. Le Maitre (geologist), 21; P. J. Mullock (radio operator), 22; J. J. van der Merwe (meteorologist), 29; M. K. Swales (zoologist), 24; N. M. Wace (botanist), 26. Van der Merwe is a South African Government meteorologist.

Gough Island lies in the path of weather approaching South Africa, and one of the tasks of the expedition will be to transmit reports five times a day to the Weather Bureau, Pretoria. By comparing simultaneous readings from Gough and from the existing station on Tristan, it should be possible to orient fronts, and to fix more correctly the centres of passing depressions so that their time of arrival in the Union may be forecast more accurately. Dr. T. E. Schumann, director of the South African Weather Bureau, is sponsoring the programme for synoptic reports, and welcomes this opportunity of testing the value of Gough Island as a permanent meteorological station. Some research will also be carried out on the air currents and local clouds formed around the island, which behaves as a small land mass in the path of a steady prevailing wind.

The main emphasis of the field-work will be on various biological programmes. First and foremost, these will consist of making thorough collections on the island; it is to be expected that there will be

several species new to science. A particular study will be made of the ecology of the flightless rail, and of the other land bird—a bunting. The populations of the fur and elephant seals will be assessed for the possible future exploitation of the two species.

The invertebrate fauna of Gough Island is almost completely unknown. The isolation of the island, the diversity of its terrain and vegetation, and its comparative freedom from human interference, will make a faunistic survey especially interesting. It is hoped to use the main plant associations as the units in this survey, although a study will be made of the fauna of particular habitats such as streams, caves, beach debris and bird nesting colonies.

The botanist will make a study of the dispersal mechanisms and agents that have brought about the distribution of some of the more interesting plants; he will also investigate systems of reproduction in a few plants. Pollen analyses of peat samples and their radiocarbon dating will give some indication of the history of plant-life on the island.

The petrological examination of the lavas of Gough may provide clues as to the nature of the Mid-Atlantic Ridge. A gneissous block of 'continental' origin has been found in the crater of Tristan, and there are rocks with similar 'continental' affinities on St. Helena and Ascension; it is hoped that the rocks of Gough will provide further hints about the nature of the Atlantic floor.

The expedition's collections will be distributed to specialists for identification after the party returns, and individual members will work on their own lines of research. Papers will be published in various scientific journals, and in addition it is hoped to collect and republish all the results in a series of papers under the name of the expedition.

CEREBRAL ACTIVITY

A JOINT meeting of Section I (Physiology) and Section J (Psychology) of the British Association on September 2 at Bristol took the form of a symposium on cerebral activity. Without being restricted to a particular theoretical issue or to data obtained from a particular discipline, this symposium provided common ground for workers from a number of different fields of inquiry relating to the problems of cerebral mechanisms. The topic chosen by the organizers of the symposium may fairly be said to be one where interdependence of different scientific disciplines is becoming increasingly apparent, and the papers which were read on this occasion were largely focused on this point.

The symposium opened with an account by Dr. C. G. Phillips (Oxford) of the essential established facts of nerve structure and function with which any theory of cerebral activity must come to terms.

Reviewing the progress in neurophysiology since the discovery late in the nineteenth century that the nervous system is built up of independent nerve cells, Dr. Phillips described the function of nerve cells in conducting impulses inwards along the dendrites towards the cell body and outwards along the axon to other nerve cell bodies or their dendrites, or to muscles. Dr. Phillips cited the evidence for a voltage gradient across the plasma membrane of the cell body and its processes and (without committing himself to a particular theory of neurohumoral transmission) outlined the sequence of events whereby signals arriving at the specialized terminals which are applied to the dendrites and cell bodies of other nerve cells result in the secretion of chemical transmitter substances which serve either to increase or to decrease this voltage gradient. The excitatory or inhibitory effect of these terminals was discussed in relation to the critical potential difference which determines the firing of a self-propagating nervous impulse.

Dr. Phillips emphasized that, in considering the nerve cell as a unit in an information system (for example, as a relay), the complexity of this unit's function must not be overlooked. Although the firing or non-firing of a nervous impulse in accordance with a certain critical voltage difference across the plasma membrane may seem a simple and unitary function, nevertheless this is only the end result of the integration of inhibitory and excitatory effects at hundreds of dendritic contacts. The cell "may be poised near to the critical firing level or it may be 'biassed off' over a range of about twenty millivolts, by preponderating inhibitory action". On one hand, there is variability in the amount of further excitation needed if the cell is to fire at all; on the other, given adequate excitation, the frequency of firing is variable over a wide range.

Dr Phillips then turned to the question of the organization of particular types of cerebral activity, and mentioned that repetitive activity may cause an enduring facilitation of transmission from cell to cell. In suggesting that such changes could conceivably impose fairly definite pathways on an originally diffuse system of interconnexions, he was careful to point out that particular patterns of activity occurring in a more or less restricted brain region might very well engage different populations of brain cells on different occasions, and that one cannot assume an unvarying anatomical substrate for particular types of cerebral activity. In fact, although certain reflex pathways can be traced and although there is some knowledge of the traffic of impulses in a few well-marked tracts within the central nervous system, the nervous events which subserve such functions as speech and skilled movement cannot at present be traced in detail.

Dr. W. Grey Walter (Burden Neurological Institute, Bristol) gave an account of some of his investigations into the function of the spontaneous electrical activity of the brain. He suggested that this activity has an 'administrative' function in cerebral organization and, more specifically, that this activity is concerned with the distribution in the brain of information derived from the sense organs and that this is best considered as operating on a statistical basis. He also maintained that this spontaneous activity is related to temperament and social behaviour.

After stressing the inadequacy of the tools which are available for the study of cerebral mechanisms, Dr. Grey Walter pointed out that useful information can nevertheless be gleaned provided that the information extracted by one's recording instruments bears a recognizable relation to the end result of the function under investigation. He suggested, for example, that the conventional voltage against time record is unsatisfactory, and that frequency analysis yields more meaningful information. He illustrated

this point by referring to the electrical changes which occur in the brain during word association procedures and during problem solving.

Another technique which Dr. Grey Walter believes is of particular value is the graphic representation of electrical activity from various parts of the brain. A cluster of cathode-ray tubes with revolving time-bases (intensity modulation) can assist in the analysis of the electrical activity of the brain as a whole, since it is then possible to trace functional relationships between different brain areas. Thus Dr. Grey Walter claimed that this technique shows that the alpha rhythm of the brain is not a simultaneous synchronous firing throughout the brain, but that instead the alpha rhythm picked up from different parts of the scalp is not completely in phase. Similarly, a rhythmically flashing light (when the time relations of the apparatus are adjusted to the periodicity of the stimulus) is reflected in a corresponding pattern in parts of the visual display of the apparatus. This pattern may appear in a unitary fashion in a particular part of the cortex (for example, the occipital lobes), may be broken down into components, with these components distributed to different parts of the brain, or may even be conserved (in the temporal region) for a period as long as 10 or 20 sec. after the cessation of the stimulus. The cerebral consequences of visual stimulation as measured with this technique show habituation effects with prolonged stimulation and also dishabituation when subjective monotony is relieved by the introduction of a reward.

Dr. Grey Walter carried interpretation a step further when he claimed that people with similar patterns of electrical activity of the brain tend to have temperamental affinity and are well fitted for social co-operation with each other.

Dr. D. M. Mackay (King's College, London) discussed some of the theoretical problems of cerebral organization. He pointed out that the fault with the kind of analogy which compares the brain to known mechanical or electronic devices is that it is too restricted, and he stressed the necessity for a more basic and general language. This, he urged, could first most properly be employed to describe what the brain does before attention is turned to the problem of how it does it. He suggested that, given adequate definition of what the brain does, one could proceed to consider various possible alternatives as to the mechanism involved and then refer back to the known facts of neurophysiology for guidance as to which of the postulated mechanisms occurs in the brain. The theory of information and control which has arisen from recent developments in communications and automatic control systems is framed in terms which, Dr. Mackay suggested, are of sufficient generality to meet the requirements he had referred to. This basic terminology, he maintained, could be applied to both physiological and psychological data, possessed a reasonable chance of surviving changes in engineering fashion, and lent itself particularly well to a theory concerned with units with a controllable probability of passing on signals (as described by Dr. Phillips).

Dr. Mackay raised two important issues which would necessarily have to govern any theoretical model of cerebral organization: first, such a model would need to be self-organizing; secondly, it would need to be able to take advantage of the redundancy of information which is implicit in a stable environment. It would thus be necessary to work out the general principles upon which such a system as the brain would have to function if it is to take advantage of the statistical regularities of the world with which it has to deal. Similarly, Dr. Mackay argued, the question of the time which such a system would require in order to adjust itself to these regularities is a crucial one. Thus there is no possibility of a model of restricted size which could make the necessary adjustments by simple trial, error and success in relation to each alternative with which it is confronted. A principle which would be more consistent with the observed facts of behaviour, Dr. Mackay contended, is one where the system starts with "the degrees of freedom coalesced", so that the process of self-development becomes one where the probability of any particular event occurring would be reduced rather than increased during the period of organization. Dr. Mackay's suggestion is thus nearer to Coghill's theory of differentiation through maturation than to learning in terms of conditioning or simple trial-and-error learning. Finally, Dr. Mackay suggested that such a model might find its first application and its first test in relation to the effects of brain injuries, since the types of breakdown which might occur with any particular model should be predictable.

Mr. M. F. Piercy (Bristol) discussed behavioural studies of cerebral dysfunction. He pointed out that the behaviour of a normal organism in a normal environment gives very little clue as to the changed behaviour which may result from physical interference with cerebral function. Similarly, this behaviour would not be predictable on the basis of present neuro-physiological knowledge. This situation, he suggested, provides a starting-point for studies which may eventually modify both psychological and physiological theories.

As an example of studies taking their cue from clinical neurology, he cited work on the incidence of aphasia in relation to cerebral dominance. Although, in right-handed patients, aphasia occurs almost exclusively in association with lesions of the left hemisphere, nevertheless left-handed patients may sustain an aphasia as a result of a lesion of either hemisphere. There is however, he maintained, evidence to suggest that aphasia is often less severe and more transient in left-handed people. In distinction to this evidence, Mr. Piercy referred to a study of paroxysmal dysphasia (with which he had been concerned). This showed that paroxysmal aphasia occurring in association with a short-lived unilateral cerebral disturbance was more frequent in left-handed than in right-handed patients, irrespective of the side of the focal cerebral disturbance. It may be, he argued, that if a function is more diffusely organized with respect to cerebral anatomy (for example, language in left-handers), not only is restitution of function more easily achieved when the disturbance is chronic, but also that function is more liable to disruption in the face of acute interference. Conversely, in the case of a function being organized within a more restricted cerebral area (for example, language in right-handers), Mr. Piercy suggested that the function might be more resistant to acute interference (such as paroxysmal) but less capable of recovery when breakdown occurs in association with a chronic lesion. This, he said, was a tentative theoretical position which should be amenable to experimental verification or disproof.

Mr. Piercy then directed attention to studies which produced anomalous behaviour without direct interference with cerebral function. Thus, if a person's

voice is recorded and played back to him through earphones with a delay of about half a second, gross disturbances of speech are liable to occur. These disturbances are not unlike those occurring in some forms of dysphasia. Similarly, a recent study carried out in Canada has shown that if sensory stimulation is reduced to a minimum for a period of hours or days, a human subject may experience hallucinations and feelings of unreality which closely resemble those occurring under the influence of hallucinogenic drugs. Similar symptomatology from radically different experimental procedures may or may not mean that a common cerebral mechanism is disturbed; but such converging lines of evidence should, he urged, at least provide strong stimulus for further research. MALCOLM PIERCY

PROGRESS OF CANCER RESEARCH

THE annual report of the British Empire Cancer Campaign has now expanded in its 1955 edition* to more than 500 pages; consequently, this short review can only deal with a very limited number of the researches financed and organized by the Campaign. The investigations to be described can be divided into three main groupings, namely, those concerned with carcinogenesis and other studies of that kind, clinico-pathology, and radiology.

In the editorial summary to the report there is a statement which says that "steady progress continues in our understanding of the manner in which cancer-producing substances act". Unfortunately, this happy thought verges on the over-optimistic.

Work on the fashionable cancer problem, the lung cancer–cigarette smoking relationship, continues at a number of centres. One of the main difficulties, from the experimentalist's point of view, is to find some tissue which has the same sensitivity as human lung and upon which the carcinogens present in cigarette smoke could be tested. Sir Ernest Kennaway and co-workers have found 3 : 4-benzpyrene, anthracene, pyrene and acenaphthylene in the condensate from tobacco smoke, and the same compounds have also been detected in smoke from the paper in which the cigarette tobacco is rolled. Sir Ernest has attacked the difficulty of test material by using tissue-culture technique:

"Several workers have demonstrated the carcinogenic power of tobacco condensates upon the skin of the mouse, but neither the species nor the tissue concerned in these experiments is of practical importance. Human tissue can be used thus only in tissue culture. Dr. Honor B. Fell, of the Strangeways Research Laboratory, Cambridge, has kindly allowed Dr. Ilse Lasnitzki to investigate this matter. Lung tissue obtained from an early human fœtus, and therefore sterile, was found to grow well in culture without replacement of epithelium by fibroblasts.

"Such cultures are being exposed to 3 : 4-benzpyrene, and to various fractions of tobacco condensates, in order to learn whether the nuclear changes known to be produced by carcinogens in other tissues can be induced in this instance also."

M. H. Salaman and collaborators have reported interesting developments in the study of the two stages of carcinogenesis ('initiation' and 'promotion'). They find that pre-treatment of mouse skin with urethane (initiation), followed by promotion with croton oil, yields skin tumours; however, urethane, although a highly potent carcinogen for mouse lung, does not induce cancer in mouse skin when applied alone. It has now been found that for the initiation stage in mouse skin not only urethane but TEM (trisethyleneimino-3-triazine) or 1 : 2-benzanthracene or β-propiolactone are also effective. The promoter, too (croton oil), can be replaced by iodoacetic acid or by chloracetophenone.

The search for chemotherapeutic drugs for cancer is undergoing an interesting change; less emphasis is now being placed on the therapeutic results achieved, and more and more on the synthesis and preparation of the drugs and upon the mechanism of their cytotoxic action from the points of view of cytology and physical chemistry.

Dr. Percy Stocks, in a study of the influence of social factors on the incidence of breast cancer in women, states:

"The figures suggest that when marriage is delayed the risk of breast cancer is increased, whatever the number of children borne, except in the group married about 30 with long duration of married life; or, otherwise expressed, that high fertility has a protective effect provided that marriage has not been delayed too long.

"In due course larger numbers will be available to establish this but taking account also of the remarkably low breast cancer rates in Japan where fertility has been high and breast feeding usually very prolonged, sufficient justification has been found for an attempt to seek answers to the following questions:

"(1) Does the mortality excess associated with zero and low fertility indicate simply a greater frequency of breast cancer, or is there also a greater probability of high malignancy when cancer occurs (i.e. higher fatality without higher inception rates)?

"(2) Is short duration of breast feeding more important than few confinements in producing the excess?"

There are no surprises in the field of morbid anatomy this year. It is good to learn that Bloom's series of cancers of the breast approaches the thousand mark, and that its full statistical analysis is being undertaken. The extraordinary statistical difficulties which bristle about every attempt to assess the effects of different forms of treatment of this disease, and the effect of varying histology, can only be solved by study of really large and uniformly recorded series such as we can hope for in this case. D. H. Patey and A. C. Thackray provide a much-needed study of the whole gland resected in cases of parotid tumour: in none of their cases (save their only adenolymphoma) was there any evidence whatever of multicentric origin—a most important point to be settled in regard to treatment. It is, however, disappointing to find they have used only ten cases.

The review of the tumours of childhood from the Hospital for Sick Children at Great Ormond Street,

* British Empire Cancer Campaign. Thirty-second Annual Report covering the year 1954. Pp. xxx+531. (London: British Empire Cancer Campaign, 1955.)

London, continues. There is a valuable collection of sixteen cases, seen over a period of thirty years, of Letterer–Siwe's disease, Hand–Schuller–Christian disease, and eosinophilic granuloma of bone, which demonstrates well the point that all three conditions are examples of a single entity. They range from solitary cured granuloma in older children to rapidly fatal, widely disseminated disease in the infant; but the transitions are too striking to be ignored. The prognosis in these cases seems to be better than is generally supposed. Four cases with solitary lesions were cured by local measures: of six with multiple lesions confined to bone, three are cured and none has died. Even in the disseminated disease there have been two complete cures.

There is also a review from the same source of neuroblastoma, the commonest tumour (except leukæmia) seen at this hospital. They are of especial interest as a base-line for the study of the effects of vitamin B_{12} on the tumour, first mentioned in last year's report. Of ninety-four cases collected, seventy-seven are known to have died, and there have been only two spontaneous regressions. Only twenty cases were regarded as suitable for treatment by surgery or radiotherapy, and of these seven survived more than two years. Nineteen cases in all have now been treated with vitamin B_{12}. All were unsuitable for radical conventional treatment, though some have had incomplete surgical or radiation therapy in addition to the B_{12}. Substantial response seems to have been obtained in about half the cases. There has so far been only one really unexceptionable cure, lasting 4½ years. Two other survivors beyond two years have recurrences; but several other cases whose follow-up period does not yet justify their being called cures have shown most gratifying immediate responses. It must still be a matter of very great doubt whether we have in B_{12} a means of cure of neuroblastoma; but it seems probable that we have a means of relief at least as effective as, say, the nitrogen mustards in chronic leukæmia. In any event, the observation throws open a new window in tumour chemotherapy.

Prof. H. N. Green, who is now director of experimental cancer research in the University of Leeds, has combined his interests in carcinogenesis and shock metabolism into a theory of carcinogenesis which has at least the merit of directing attention to some unfamiliar facts. Briefly, his main chain of reasoning is this. Many, perhaps all, chemical carcinogens have an inhibitory effect on the take of transplanted tumours. Some fractions of tar which are not carcinogenic share this inhibitory action with the carcinogens. (Tetraphene is the active agent in some of these extracts.) Use of these non-carcinogens has made it possible to show that the inhibitory action on transplanted tumours is a relatively specific one, not due to any general depression of the host's health; it has also been shown that there is inhibition of the primary induction of tumours by the carcinogens. The inhibitory action is antagonized by agents, such as cortisone, which depress the immunity to transplanted homologous tissues. These, and other arguments, lead to two hypotheses, of which the first may be readily accepted as possibly true—that the tumour-inhibitory action of carcinogens and non-carcinogens alike is due to a stimulation of the homotransplant immunity reaction. Given this, Prof. Green assumes that the action of these agents must be on the antigenic structure of the cell, and proposes in his second and major hypothesis the view that the essential action of a carcinogen on a cell consists in the alteration of its antigenic structure so that it loses its individuality and becomes antigenically neutral. That loss of antigenic specificity is an important characteristic of some tumour cells—of all transplantable tumours, in fact—is a proposition that few would deny; that it is a fundamental characteristic of all tumours is harder to accept. But the hypothesis is at least fruitful of experiments.

There is a tantalizingly brief reference to work in the cytogenetics department at Manchester on the sex chromosomes in transplanted tumours in *Microtus*, suggesting that the host contributes chromosomes to the tumour cell, of which one hopes to hear more in the future.

The range of the physicist in the realms of cancer research and treatment grows wider and more diverse year by year. Basic physical studies continue, and from them are developed new methods of instrumentation and measurement. The use of radioactive isotopes is now an everyday matter in a very large number of departments; but work is still going on, and is needed, on increasing the sensitivity and scope of present-day methods of measurement. The construction of automatic devices for the measurement and localization of radioactive material within the human body and on chromatograms is reported from several centres, and the co-operation of the physicist is being sought more and more by his colleagues in their biochemical and biophysical investigations, as well as in the more accustomed radiotherapeutic uses of radiation.

The commercial development of equipment capable of producing beams of radiation of 1 MeV. and greater has necessitated increased study of the radiation effects occurring at these levels, and also the production of methods of measurement more suitable for these energies. A calorimetric method of dosimetry seems to offer a very good alternative to the more standard ionization methods for beams of X-rays of quanta 3 MeV. and greater. The use of a 1,000-curie source of cobalt-60 has also led to the study of the dose distribution obtained in the beam, and consideration of the best use of the beam for radiotherapy.

With the increasing use of radioactive materials, and wider range of radiations now in current use, the study of health physics achieves greater prominence each year. In this report, as well as the more usually considered radiation hazards, studies are reported on the possibility of the protection of bronchitics and asthmatics against 'smog', both indoors and out.

At the same centre the radon content of the atmosphere under conditions of fog or excessive smoke is being measured with the aid of specially built apparatus which permits the measurement of small amounts of radioactive gases.

The effect of whole-body radiation is being studied at a number of centres with particular reference to protective materials and to the result of partial shielding. The use of iron-59 as an indicator of the effect of various dosage-levels on the erythropoietic system, and also of the effect of changes in dosage-rate and of the comparative effect of X- and neutron-irradiation, continues. This should be of considerable value in assessing the total amount of whole radiation received either by design, after radiotherapy, or by chance after an occupational accident or thermonuclear explosion.

JAMES PARKINSON (1755–1824)

By JOAN M. EYLES

THE incidence of Parkinson's disease, or paralysis agitans, is sufficiently high for most people to know something of its nature, or at least to have heard of it. Yet the story of the life and activities of the man who gave this crippling disease his name is not widely known, and it may surprise many to learn that in his day he attained distinction, not only as a physician, but also as a geologist and as a social reformer.

On September 17, an inscribed marble tablet was unveiled in St. Leonard's Church, Shoreditch, to commemorate the memory of "James Parkinson, of Hoxton, Surgeon and Apothecary". A short service preceded the ceremony, and the Rev. Meredith Davies, in an address to the congregation, described Parkinson's close association with the parish and his wide humanitarian interests. He also mentioned the "untiring efforts and tenacity" of Dr. A. D. Morris, formerly medical superintendent of St. Leonard's Hospital, who for a number of years had not only interested himself in Parkinson, but also had been instrumental in inspiring local interest in this remarkable man.

The tablet, the funds for which had been provided by the generous efforts of the nursing staff of St. Leonard's Hospital, was then unveiled by Dr. Morris, who pointed out that it commemorated Parkinson's geological as well as his medical achievements. Among those present in the church were two direct descendants of Parkinson, Dr. Robert Tringham and Mr. Herman Saunders, while local interest was marked by the presence of the Mayor of Shoreditch. Members of the medical profession who attended the ceremony included Sir Zachary Cope, president of the History of Medicine Section of the Royal Society of Medicine, Mr. Macdonald Critchley, Sir Allen Daley, Dr. Donald Hunter, Mr. T. B. Layton and Mr. A. Dickson Wright. After the service Miss Bell, matron of St. Leonard's Hospital, and her staff entertained the visitors to tea at the hospital, where interested glances were directed to the plaque recording the fact that Nurse Edith Cavell had once been assistant matron there.

Earlier in the week Parkinson's name had been to the fore at the meeting of the Second International Congress of Neuropathologists, held at the Royal College of Surgeons of England during September 12–17. The president of the congress, Dr. J. G. Greenfield, referred to him in his opening address on "Historical Landmarks in the Pathology of Involuntary Movement", and several papers read during the week were concerned with Parkinsonism and Parkinson's disease. Very appropriately, as 1955 is the bi-centenary of Parkinson's birth, an exhibition was arranged at the College by the librarian and Dr. Morris to illustrate the many facets of Parkinson's life. A portrait, however, could not be discovered, and one is still being sought.

James Parkinson was born in Hoxton on April 11, 1755, and spent all his life in the parish. The son of a surgeon, he himself qualified in 1784, and in 1785 attended the surgical lectures of John Hunter, and took full notes in shorthand. Many years later these were transcribed and published by Parkinson's son, James Keys Parkinson, who was also a surgeon.

Little is known of Parkinson's early life, except that as a pacifist and political reformer he was the author of many pamphlets written either anonymously under the pseudonym of "Old Hubert", including "Revolutions without Bloodshed; or Reformation Preferable to Revolt", which appeared in 1794. He was a member of various secret societies, including the London Corresponding Society, and when some members of the latter were arrested and charged with complicity in what became known as the "Pop-Gun Plot", Parkinson gave evidence before the Privy Council in their favour and published pamphlets maintaining their innocence.

Parkinson then seems to have directed his activities into rather more innocuous channels, issuing in 1799 "Medical Admonitions for Families", which went into five editions in the next ten years, followed by the "Villager's Friend and Physician" and "Dangerous Sports" in 1800. In the latter year he also published another best-seller, his "Chemical Pocket-Book", which was "calculated, as well for the occasional reference of the Professional Student, as to supply others with a general knowledge of Chemistry". It had a good reception, and was reprinted in the United States, with notes by James Woodhouse, professor of chemistry in the University of Pennsylvania. In this book, as in other of his works, Parkinson showed he had read widely, much of the "Pocket-Book" being a digest of recently published work in chemistry.

His first geological work, a large quarto with many illustrations, appeared in 1804, with the impressive title "Organic Remains of a Former World: Volume I, The Vegetable Kingdom". This volume includes a useful historical review of early books about fossils. Two more volumes appeared in 1808 and 1811 respectively, and were concerned with vertebrate and invertebrate fossils. In the histories of geology, Parkinson's work has received less notice than it deserves, although it has recently been stated that "its appearance was the outstanding event in the history of our scientific knowledge of British fossils"[1]. There is little doubt that Parkinson, who was an original member of the Geological Society of London, was highly esteemed by his contemporaries for his scientific knowledge of fossils at a time when most people were content merely to collect them. In several papers published in the *Transactions of the Geological Society of London*, he assisted in naming the fossils. Parkinson himself had a paper in the first volume of the *Transactions*, entitled "Observations on some Strata in the Neighbourhood of London, and the Fossil Remains contained in them", which is noteworthy as the first detailed account of the strata of the London basin. In this paper he refers to the discovery of William Smith, that strata could be identified by their contained fossils. Elsewhere Parkinson mentions his friendship with the Rev. Joseph Townsend, who was the first to appreciate the value of Smith's discovery.

Parkinson wrote many articles for medical journals which indicate he was a careful observer; and he published several tracts which show his zeal as a social reformer. It was in 1817 that he published the "Essay on the Shaking Palsy" which has brought

him eponymous immortality. In 1822 he received recognition from the Royal College of Surgeons of England with the award of its Honorary Gold Medal. This is of greater interest when one learns that he was the first to receive the award, which had been instituted in 1802, and that it has only been bestowed fifteen times in the past hundred and twenty years. It is stated in the minutes (a copy of which was included in the College exhibition) that the award was made "in consideration of his useful labours for the Promotion of Natural Knowledge particularly expressed by his splendid Work on Organic Remains".

Parkinson died in 1824 and was buried in the graveyard of St. Leonard's Church, though the exact location of his grave is unknown. His fine collection of fossils was sold at public auction in 1827, some being acquired by Sedgwick for the museum in Cambridge, others passing to Oxford, Haslemere, and into private hands. Some now rest in the British Museum (Natural History). His name is preserved in geological as well as medical circles, for the ammonite *Parkinsonia parkinsoni* and the crinoid *Apiocrinus parkinsoni* are both well-known fossils from the Inferior Oolite. It is satisfactory to learn that medical historians are now busy rescuing Parkinson from undeserved obscurity[2].

[1] Challinor, J., *Ann. of Sci.*, **6**, 46 (1950).
[2] *Lancet*, **1**, 761 (April 9, 1955).

OBITUARIES

Prof. F. Blakemore

THE sudden death on August 7 of Prof. Frederick Blakemore at the early age of forty-nine comes as a great shock to his friends and colleagues both within and without university circles. He qualified at the Veterinary School, University of Liverpool, in 1927, and then spent three years in general practice. In 1931 he moved to Cambridge as veterinary investigation officer for the eastern counties, where he remained until 1948. This was a period of intense activity demanding the closest collaboration with veterinary surgeons, agriculturalists and research workers, in a variety of fields. He would leave early in the morning to visit veterinary surgeons and farmers in the wide district which he covered, and his reputation as a sound adviser on all problems of animal health and disease was unrivalled. On his return he would plunge himself into his laboratory investigations, for which his enthusiasm was unbounded. The volume and high quality of his work during this period were an example to the younger men with whom he was associated. He had an uncanny knack of selecting the problems in the field which were worthy of intensive laboratory study. The impact of his scientific mind on a problem was shown by his unusually clear exposition of a subject. The extensive researches which he completed at Cambridge could not have been undertaken without the help of collaborators, many younger than himself, who owe much to his kind guidance and stimulating encouragement. His distinction in the research field was recognized by the award of the Dalrymple-Champneys Cup by the British Veterinary Association.

The high qualities which emerged during this period marked Blakemore as a man of sound judgment, and it was no surprise to his friends that he was appointed superintending investigation officer for England and Wales. This branch of the Ministry of Agriculture had reached a critical stage in its development. The absorption of the county veterinary officers had been completed, but the service had not been moulded into a closely knit unit. To this task Blakemore brought his gifts of dogged persistence, persuasion and foresight, so that with the help of his colleagues he was able to build up an independent service complementary to the field officers of the Animal Health Division.

In 1948 he was appointed to the newly established chair of veterinary studies in the University of Bristol. He found in university circles, particularly in the person of the Vice-Chancellor, a keen interest in veterinary science and a desire to fashion a school on lines differing possibly from those of the older veterinary schools. Blakemore tackled with enthusiasm and sound common sense the problem of utilizing the resources of existing University departments, but at the same time developing an independent veterinary school with ramifications in Bristol and at the field station at Langford. The buildings which have been erected are a tribute to his sound planning; but, of themselves, they would never have created a flourishing school. The measure of his success was his ability to attract from the profession young men who were fired with his own ideals. The University of Liverpool recognized his outstanding merits by awarding him an honorary degree of doctor of veterinary science.

The high standing of the Bristol School is a collective victory; but it owes much to the knowledge which Blakemore brought of the practical side of his profession, as well as to his ability to take firm decisions and his clear-sighted judgment of men. Undoubtedly by his untiring efforts he spent himself to the limit. He will be sadly missed by his professional colleagues. The deepest sympathy is extended to his widow, who loyally supported him, and to his family.

R. E. GLOVER

Mr. E. T. Leeds

EDWARD THURLOW LEEDS, who died at his home, 88 Woodstock Road, Oxford, on August 17 at the age of seventy-eight, was successively assistant keeper and keeper of the Ashmolean Museum, Oxford, and was an archæologist of outstanding ability.

As assistant keeper of the Department of Antiquities in the Ashmolean during 1908–27, Leeds was responsible for much of the day-to-day work in the Department. His systematic mind and studious attention to detail, as well as his strong sense of custody, made him remarkably well-fitted for such a post in a great and growing museum, and his flair for rapidly assimilating new knowledge soon gave him a mastery over all the material under his charge. From 1928 until 1945, when he retired, Leeds was keeper both of his Department and of the Ashmolean. Though he never neglected his Department and never failed to keep a firm daily grip on its working, administrative duties, which fell to him as keeper of the Museum, came to occupy more and more of his time, involving, as they did, the planning of no less than four major additions to the fabric (the Weldon wing, the Griffith Institute, the Drapers' wing and the Beaumont Street wing) as well as several internal reconstructions of fabric or fittings. His flair for attention to detail ensured that all this work took place with but the minimum interference with day-to-day duties and with practically no interruption of the Museum's service to the public.

That Leeds, as a busy and successful museum official, did not neglect the claims of scholarship is shown by the many excavations on local sites which he undertook (notably those of the Neolithic causeway and settlement at Abingdon, Berks, the Iron Age camps at Chastleton, Oxon, and Chun Castle, Cornwall, and of the Anglo-Saxon village at Sutton Courtenay, Berks) and by the list of six books and more than ninety smaller papers which appear in the bibliography of his writings in the forthcoming volume of essays entitled "Dark-Age Britain" offered to him by a group of his friends and pupils. His chief work lay in Anglo-Saxon studies. His book, "The Archæology of the Anglo-Saxon Settlements", published in 1913, can fitly claim to have been epoch-making, as it laid the foundation of all the more recent work on the subject, and showed, once for all, how great a contribution archæology could make to a study which had previously seemed to be almost solely the prerogative of the historian. He followed this with two more books and numerous papers, which showed how, though his views may have been modified in detail as the years passed, his main arguments stood firm in his own mind and have, indeed, now won general acceptance. Besides his work for Anglo-Saxon studies, Leeds also made major contributions to scholarship in several other fields, notably with his book "Celtic Ornament" (1933), and with his work on numismatics (Roman and Chinese) and his several papers connected with Oxford inns and traders.

Leeds was Fellow, and later honorary Fellow, of Brasenose College, Oxford, and was also elected this year to an honorary fellowship of Magdalene College, Cambridge, where he had been an undergraduate. He was a Fellow of the Society of Antiquaries and a vice-president during 1929–32, and an honorary associate of the Royal Institute of British Architects.

D. B. Harden

Prof. Haakon Shetelig

Haakon Shetelig, formerly director of the Bergen Museum and professor of archæology there, who died on July 23 at the age of seventy-eight, was a distinguished authority on Scandinavian prehistory and on the archæology of the Vikings. He was particularly well known in Britain, both for the admirable account in his "Scandinavian Archæology" (Oxford, 1937), written in conjunction with the philologist Hjalmar Falk, and for his interest in the archæological traces of the Vikings in the British Isles, of which he left a permanent memorial in the six parts of "Viking Antiquities in Great Britain and Ireland", published in 1940 (pts. I–IV) and 1954 (pt. VI) on behalf of the Norwegian Scientific Research Fund of 1919. Much of the writing was contributed by British and Norwegian scholars, but Shetelig edited the whole work and himself contributed a masterly introduction to the history of the Vikings in Western Europe.

Shetelig was a genial and hospitable as well as a learned man, and he had an abiding love and respect for Britain. He had a particularly warm place in his heart for the amateur scholar, whom he regarded as the fine flower of our society in the days of its prime. It must have given him peculiar pleasure to be awarded the Gold Medal of the Society of Antiquaries of London, a recognition which came to him in 1939.

Grahame Clark

Dr. C. H. N. Jackson, O.B.E.

Dr. C. H. N. Jackson, chief entomologist of the East African Tsetse Research Organization, died in hospital in England on July 28. His whole career was devoted to research in East Africa, his first appointment being in 1927 as zoologist to the Department of Game Preservation in Tanganyika. C. F. M. Swynnerton was the head of the Department, and Jackson was one of the team of able young men who Swynnerton inspired to work on the tsetse fly which then, as now, was one of the major problems of East Africa. Swynnerton persuaded his Government and the Colonial Office to set up a separate Department of Tsetse Research, and Jackson was appointed as survey entomologist to it in 1932. He became senior entomologist in 1936. In 1948 tsetse research became the responsibility of the East African High Commission, and Jackson was appointed research officer in the Tsetse Research Organization, becoming chief entomologist in 1951. He held the degree of D.Sc. of the University of London, and was appointed O.B.E. in the Queen's Birthday Honours List this year.

Jackson was, like Swynnerton, an excellent field-worker, and spent much of his time almost completely isolated from the amenities of civilization and even from his colleagues. His work, carried out over so many years at Kakoma in Central Tanganyika under difficult and uncomfortable conditions, provides data on the tsetse of continuing value to all concerned with similar problems. But Jackson was not only a field-worker; he combined this with rigorous academic standards, and an ability to keep up to date with theoretical and laboratory work in his own and allied subjects. He will be particularly remembered for his work on natural populations. This applied primarily to the tsetse fly, but is accepted by others as applying much more generally to other ecological problems. A particular contribution was his development of the 'marking' technique, by which tsetse flies were marked with spots of paint in such a way that the date and place of release could be indicated and recaptures could also be recorded. He spent much of his leave analysing his data, and was among the first field-workers to apply the methods of Sir Ronald Fisher to his results. He had a real enthusiasm for his subject which he communicated to those who discussed his work with him either in the laboratory in Britain or in the field in East Africa. His work, though individual, was also part of the work of a team of scientists who have done much to make tsetse control over large areas a possibility.

Kenneth Mellanby

Mr. R. L. Collett, M.B.E.

Ronald Leslie Collett, who died on August 15, will be remembered for the devoted service he gave to the profession of chemistry as assistant secretary (1925–44) and as registrar (1945–51) of the Institute of Chemistry of Great Britain and Ireland, now the Royal Institute of Chemistry. Throughout that period he was always available for consultation by students and members of the Institute on matters affecting their careers, and there were few who at some time or other did not benefit from his advice and help in resolving professional or personal difficulties. Even those who at first were overawed by the luxuriance of his eyebrows or his somewhat didactic manner soon came to regard him as a

friend and confidant. His obvious sincerity and complete honesty of purpose won for him the esteem and affection, not only of innumerable chemists, but also of many government officials, fellow bird-watchers and members of the Savage Club—and, not least, of those whose opinions he combated most vigorously.

Born in 1886, Collett was educated at St. Paul's School, London, and, after graduating in natural sciences from Trinity College, Cambridge, he specialized in the chemistry of food, drugs and water at King's College, London. He was elected a Fellow of the Institute of Chemistry in 1913. During the First World War he was first commissioned in the Middlesex Regiment, but was later transferred for specialist duties in connexion with water supplies and served for three years in France as a captain in the R.A.M.C. After the War he was successively chemist to a brewery and a member of the scientific staff of the newly formed British Leather Manufacturers Research Association.

He took a close interest in the work of several scientific societies and had been a vice-president of the Society of Public Analysts, now the Society for Analytical Chemistry. Before his appointment as a salaried officer of the Institute of Chemistry, Collett had been a member of its council and had served as honorary secretary and honorary treasurer of its London Section. During the Second World War he gave valuable assistance to government departments in connexion with the utilization of the services of qualified chemists and was afterwards appointed M.B.E. After his retirement he was attached in an advisory capacity to the Association of University Teachers, and continued to act as a consultant on the engagement and conditions of service of chemists in industry.

H. J. T. Ellingham

NEWS and VIEWS

Chemical Technology at the University of Edinburgh : Prof. K. G. Denbigh

The first occupant of the recently instituted chair of chemical technology in the University of Edinburgh is to be Dr. K. G. Denbigh, who will take up his duties there in October. Dr. Denbigh is at present a University lecturer in the Department of Chemical Engineering, Cambridge. He is forty-four years of age, and was educated at Queen Elizabeth's Grammar School, Wakefield, and at the University of Leeds, where he graduated with first-class honours in chemistry in 1932. He continued his studies by research on the fluorides of sulphur and was awarded the degree of Ph.D. His old University has recently recognized his distinguished contributions to a wide field of scientific subjects by conferring upon him the degree of D.Sc. Dr. Denbigh's career has been almost equally divided between chemical industry and university teaching. He has held appointments with Imperial Chemical Industries, Ltd., and with the Ministry of Supply Royal Ordnance Factories and was for a time a lecturer in the University of Southampton. In 1948 he was appointed to a University lectureship in the then newly-established Department of Chemical Engineering at Cambridge, and from the start he has been largely responsible for the teaching of chemical thermodynamics and associated subjects. His researches have been mainly concerned with the kinetics of reactions between gases and liquids and between gases and solids, and he has published a number of papers on these topics and in the general field of chemical kinetics and thermodynamics. His monograph "The Thermodynamics of the Steady State" (Methuen, 1951) has become very well known, and a text-book, "The Principles of Chemical Equilibrium", has been announced by the Cambridge University Press for the autumn. Dr. Denbigh is a Fellow of the Royal Institute of Chemistry and a member of the Institution of Chemical Engineers, and he is a member of the Education Committee of the latter organization.

The Animal Health Trust : Dr. K. C. Sellers

The Animal Health Trust has appointed Dr. Kenneth Charles Sellers to be director of its new Farm Livestock Research Station at Stock, Essex. Dr. Sellers, who is thirty-nine, is at present in the service of the Ministry of Agriculture as veterinary investigation officer in Yorkshire. He was trained at the Royal Veterinary College, London, and then went to the University of Cambridge, after which he was appointed to the staff of the Institute of Animal Pathology at Cambridge. He remained at the Institute, with the exception of war service, until joining the Ministry of Agriculture. Dr. Sellers has already contributed some thirty papers on widely varying aspects of disease problems, including a survey of losses during pregnancy and parturition in sheep, vitamin deficiencies in livestock, bovine mastitis, ketosis in pregnant ewes, and various nutritional problems. Pending completion towards the end of the year of a new range of laboratories at the Farm Livestock Research Station at Stock, temporary laboratory accommodation has been provided at Lilystone Hall, where alterations have been made to meet library, lecture hall and reception room requirements and for provision of residential flats for various members of the staff. The nucleus staff from the old Farm Livestock Station at Houghton Grange in Huntingdonshire have moved to Stock.

Perkin Centenary Celebration in 1956

In 1856, William Henry Perkin, then aged eighteen, discovered the first synthetic dyestuff, later called 'mauve', and from this discovery have developed the modern dyestuffs industry and the greater part of the world's organic chemical industries. It is planned to celebrate in London, during May next year, the centenary of this discovery, and six bodies are co-operating in making the arrangements: the Royal Society; Chemical Society; Society of Chemical Industry; Society of Dyers and Colourists; Royal Institute of Chemistry; and the Association of British Chemical Manufacturers. Under the patronage of H.R.H. the Duke of Edinburgh, the president of the celebration is the president of the Royal Society, with the presidents of the sponsoring societies as vice-presidents. An organizing committee has been set up under the chairmanship of Sir Robert Robinson, and four sub-committees have been formed to deal with the following aspects: technical and

scientific; social; finance; and publicity. It is intended to appeal for a fund of £100,000 and with this money to set up a trust fund which will finance Perkin Centenary Scholarships designed to promote, advance and encourage technical education in relation to all aspects of the fabrication or application of colouring matters. The main part of the celebration will take the form of a series of five lectures dealing with the effects of Perkin's discovery on life and industry during the past hundred years. There will also be a conversazione at which an opportunity will be given for overseas delegates to meet one another and the delegates from Britain. The general secretary for the celebration is J. W. Nicholls, c/o Society of Dyers and Colourists, 19 Piccadilly, Bradford 1, Yorks.

Independent Television Authority: Croydon Transmitting Station

The first station of the Independent Television Authority, to be known as the Croydon Station, was officially opened by the Mayor of Croydon on September 13, and full-scale programmes started on September 22. This is also the first television station in Great Britain to operate in Band III (174–216 Mc./s.), the frequency of the vision carrier being 194·75 Mc./s. and that of the sound carrier 191·27 Mc./s. The British standard 405-line system is used, in common with the existing B.B.C. Band I service. The station is situated on high ground, 375 ft. above sea-level, at Beulah Hill, and the mean height of the aerial above ground-level is 175 ft. The aerial consists of a vertical array of eight stacks, each stack containing four half-wavelength dipoles set at the corners of a square: the two top and two bottom stacks are rotated 11° with respect to the remaining four stacks in order to achieve as nearly as possible a circular radiation pattern in the horizontal plane, and the array has a gain of six relative to a half-wavelength dipole. The radio-frequency power outputs of the vision and sound transmitters are 10 and 2·5 kW., respectively, and the corresponding effective radiated powers are thus 60 and 15 kW.

It has been estimated that, with these radiated powers, the primary service area, which is included within the 2 mV./m. field-strength contour, extends roughly thirty miles to the north and west from the transmitter, and some twenty miles to the east and south, though there is a narrow belt of shadow a few miles wide, and with field strengths between 0·5 and 2 mV./m., running just to the south of the North Downs. Within this area there are about 9·5 million potential viewers. The 0·5 mV./m. field-strength contour, defining the limit of the secondary-service area, lies five to ten miles beyond the 2 mV./m. contour, the greatest ranges being in a north-easterly direction from the transmitter, and a further million potential viewers are contained within this belt. Such measurements of field strength as have been made agree well with the predicted values. It is the intention of the Authority to increase in the near future the effective radiated power of the Croydon station to 120 kW.; and it is anticipated that the second station of the Authority, near Lichfield, will be ready to radiate programmes, also in Band III, early in 1956.

International Fisheries Convention: Meeting of the Permanent Commission

The fourth meeting of the Permanent Commission set up at the International Fisheries Convention, 1946, was held in London during September 13–16. Delegations attended from all the thirteen Member States—Belgium, Denmark, Federal Republic of Germany, France, Great Britain, Iceland, Ireland, The Netherlands, Norway, Poland, Portugal, Spain and Sweden—and observers from the International Council for the Exploration of the Sea, the United Nations Food and Agriculture Organization, and the International Commission for the North-West Atlantic Fisheries. The discussions at the meeting centred mainly upon the 'industrial fisheries', the minimum size of mesh of trawl nets, and the arrangements for enforcing the provisions of the Convention. The provision whereby any catch not destined for human consumption (that is, 'industrial fisheries') may contain up to 10 per cent of undersized fish of species which the Convention protects was extended until May 1958 in order to allow further time for the International Council for the Exploration of the Sea to report on the problem. In view of the considerable 'industrial fishery' for sand eels (*Ammodytes*) that has developed during the past two years in Denmark, the Commission agreed to include sand eels in the species which are exempted from provisions relating to the minimum size of mesh. As a result of experiments on the relative selectivity of light and heavy trawls and the effects of the prescribed minimum mesh size for trawls in the southern part of the Convention area, two interim measures were decided upon: first, that the 75-mm. minimum mesh should remain unchanged for a further year; secondly, that trawl nets made of single twine and containing no manila or sisal might have a minimum mesh size of 5 mm. less than that applicable to other trawl nets. The International Council for the Exploration of the Sea was asked to advise on a more detailed definition of a light trawl. The Commission will hold its next meeting in London, starting on May 8, 1956.

Paint Testing Laboratory at the Borough Polytechnic, London

On September 16, Lord McCorquodale opened the new Paint Testing Laboratory at the Borough Polytechnic, London, and presented to Mr. Hubert Secretan, the chairman of the Governors, testing equipment purchased from funds subscribed by industry, through a committee consisting of representatives of the Society of British Paint Manufacturers; the London Colour, Paint and Varnish Manufacturers' Association; and the London Sections of the Paint Manufacturers and Allied Trades Association and the Oil and Colour Chemists' Association. The testing equipment installed is similar to that used extensively in government and other laboratories for the examination of the properties of paints; for example, resistance to humidity and other atmospheric conditions. The Borough Polytechnic, which is one of the twenty-five institutions in England and Wales recognized by the Ministry of Education as senior colleges of technology, has for sixty years provided courses in paint technology. Lord McCorquodale congratulated the Polytechnic on its pioneer work and appealed to industry to make the fullest use of the facilities provided, at a time in the history of Britain when all industries—and the nation as a whole—require technologists of high calibre and sound training. Industry, he said, must not only be concerned with present and immediate needs, but should attempt also to forecast the changes likely to come about in the next decade.

Journal of Electronics

THE first issue of the *Journal of Electronics*, a new scientific publication, appeared in July (London: Taylor and Francis, Ltd. 20*s*. each part; subscription, £5 10*s*. for 6 parts). Sir Edward Appleton welcomes the new journal in a foreword to the first issue, and the editor, Dr. J. Thomson, explains and discusses the title, to which different readers might otherwise attach very different meanings. Prof. N. F. Mott will be consultant editor on the new journal. The *Journal of Electronics* is to cover any behaviour of electrons when they are nominally free or only loosely bound. The chemistry and metallurgy of any materials the properties of which contribute to, or are affected by, the behaviour, design and properties of new electronic devices are included; but descriptions of equipments using electronic devices, already well catered for elsewhere, are excluded. Several of the papers in the first issue deal with electron dynamics; but one of the longer papers deals with the structure and magnetic properties of ferrites, and another with a mass spectrometer. The second issue will, according to its table of contents announced in the first issue, be devoted almost entirely to the intermetallic semiconductors. The new journal will appear every two months. Its progress will be watched with much interest. Comparisons with the *Philosophical Magazine* (also published by Messrs. Taylor and Francis), the size and layout of which are used, may be inevitable; but they could act as a powerful spur, particularly to the many young scientists engaged in the fields now specially catered for, to set and maintain a high standard of scientific writing and hence to justify fully the new venture.

U.S. Geological Survey Technical Files in Palæontology

A TECHNICAL file concerning the Cambrian fossils of the world has been prepared by personnel of the Paleontology and Stratigraphy Branch of the U.S. Geological Survey from an earlier file compiled by Dr. C. E. Resser, of the U.S. National Museum. This is now available as an 'open file report' of the U.S. Geological Survey, and positive microfilm or paper facsimile copies may be purchased at cost of reproduction by filing a prepaid order with the Map Information Office, U.S. Geological Survey, Washington 25, D.C. Charges are based on current materials and labour costs. As in previous releases of technical files, no guarantee of the accuracy of the file is made. It consists primarily of uncritical compilations in large part brought together by clerical help, and commonly not checked as to accuracy or consistency of usage; on the other hand, the file is a useful research tool in judicious hands, and it is being made available to the profession at large. The nature of the material and the amount of professional time that would still be required to prepare it for publication has determined the form of release. The technical files of the Paleontology and Stratigraphy Branch that are now available are: objective synonymy catalogue of the Cambrian fossils of the world (5 microfilm rolls; more than 14,000 images); compendium of palæobotanical species (28 microfilm rolls; 135,490 images); palæobotanical bibliographical index (5 microfilm rolls; 17,356 images); Mesozoic species index—North and Central America, including the Caribbean (8 microfilm rolls; 25,459 images); Mesozoic species index—South America (3 microfilm rolls; 8,345 images); Cushman catalogue of Foraminifera (33 microfilm rolls; 118,967 images). The original records and subsequent additions to them remain available in the Survey's offices in the U.S. National Museum, and with the Museum's "Cushman Collection".

Wild Life Preservation in Burma

U. TUN YIN, formerly of the Burma Civil Service, reports that the Wild Life Protection Act of 1936 is still in force in Burma (*Oryx*, 3, No. 2; August 1955). The only blot appears in section 6, which, *inter alia*, gives protection to the rhinoceros. Unfortunately the section contains the phrase "provided that it shall not be an offence for any physician or druggist to possess or sell, or for any person to possess for private medical purposes rhinoceros blood or any preparation thereof". This exception was essential or the Act would not have been passed; many people in Burma have implicit faith in the efficacy of rhinoceros blood for medicinal purposes. U. Tun Yin writes that the Forest Law Amendment Committee has recommended the deletion of the proviso and this should lead to greater conservation of the rhinoceros. A further difficulty arising from the Act is that its application to the States comprising the Union of Burma is complicated and obscure. It does not apply, for example, to the Kachin State. The few Sumatran rhinoceros which survive there are wholly unprotected, as are also, in that State, takin, musk-deer, panda, goral, serow and other rare animals. If these are to be saved, not only must the Act be extended to the Kachin State, but also the Kachin Hill Tribes Regulation and the Hkamti Long Administration Order must be amended. There should be a uniform wild-life protection law throughout the Union of Burma. At present the law is almost ineffective, for there is no central authority directly responsible for its enforcement.

New Ammonites

SOME new and little-known ammonites in South Africa have recently been described by E. C. N. van Hoepen (*South African J. Sci.*, 51, No. 12; July 1955). One, an unusually large form of *Pervinquieria* (*Styphloceras*) *multicostata* from Zululand, is described as the biggest *Pervinquieria* yet discovered. From the Umsinene River come some large specimens which represent a new species that has been named *Puzosia willemventeri*; a new genus of *Scaphites*, represented by a new species, is described under the name *Zuluscaphites orycteropusi*. A new genus, *Collignoniceras*, of the family Acanthoceratidæ, is established for two species, *C. hammersleyi* and *C. peregrinator*, and for a species previously described by Venzo as *Mortoniceras vinassai*. In the family Pachydiscidæ, a new species of the genus *Lewisiceras* is introduced and compared with four similar-looking species from Madagascar. This is the first record of this genus in South Africa. A new family, Gauthiericeratidae, is established for the two genera *Peroniceras* de Gross. and *Gauthiericeras* de Gross. Two new species of *Peroniceras*, *P. platycostatum* and *P. undulato-carinatum*, and three new species of *Gauthiericeras*, *G. libertae*, *G. obesum* and *G. planulatum*, are described. A family, Eriloceratidae, has been created for three new genera of keeled *Albian ammonites*, which lose their keel at a late stage; they have parallel flanks and their ribs are more or less overhanging backwards on the shoulder.

The Starfish

The eighth number of *The Starfish*, the journal of the Association of School Natural History Societies, is, like its predecessors, a tribute to the vitality and enthusiasm of natural history students and their teachers in British grammar schools. Mr. A. R. P. Hayden contributes the main article, which describes the work of the Nature Conservancy; David Spires, of Bishop's Stortford College, writes on observations he has made on the ecology of the house-sparrow during 1953–54; and R. J. Cryer, of St. Paul's School, gives an account of his investigation into a shaker mutant in mice. The usual reports from member schools are included, as are the yearly observations on mammals, birds, butterflies and moths, and plants. The report on the annual essay competition describes the number of entries as being particularly disappointing. A charge of 2*s*. for the journal is made to non-members of the Association. Each year the Society holds an exhibition which, in 1955, will be held in London at the British Museum (Natural History) on October 15; it is open to the public.

Fat Accumulation by Algae

On the basis of extensive analyses, D. M. Collyer and G. E. Fogg have come to the conclusion that the generally held view that fat accumulation is characteristic of certain classes of algae stands in need of revision (*J. Exp. Bot.*, 6, 17, 256; 1955). In the investigations now reported, the fatty acid, unsaponifiable lipoid, total cell nitrogen and polysaccharide contents of representative algae from different classes have been ascertained at different stages during their growth in pure culture. Species belonging to the same class have been found to resemble each other in the relative amounts of crude protein, fats and hydrolysable polysaccharide which they contain. Marked differences in composition between species belonging to different classes have been found; but it is concluded that there are no fundamental differences in the physiological relations of fat accumulation in the algae belonging to the Chlorophyceae, Euglenineae, Xanthophyceae and Bacillariophyceae. Representatives of the Rhodophyceae and Myxophyceae, although they may in certain circumstances have moderately high fat contents, appear to differ in that in them fat accumulation is not associated with low cell nitrogen contents as it is in the other algae examined. No well-defined correlations between the unsaponifiable lipoid and either the fatty acid or total cell nitrogen contents of the algae have been found. *Euglena gracilis* var. *bacillaris* has been found to have a rather higher content of unsaponifiable lipoid than the other algae.

Zoological Nomenclature

As from January 7, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full particulars of these cases have already been published (*Bull. Zool. Nom.*, 11, Parts 7 and 8; 1955). (1) *Gnathophyllum* Latreille, 1814 (Cl. Crustacea, Order Decapoda), validation of emendation from *Gnatophyllum*; Hippolytidae Bate, 1888, and Eugonatonotidae Chace, 1937, validation of; (2) Mayaitidae Spath (L.F.), 1923 (Cl. Cephalopoda, Order Ammonoidea), validation of; (3) *Lernaeocera* Blainville, 1822 (Cl. Crustacea, Order Copepoda), validation of emendation from *Lerneocera*, and designation of a type species for; (4) proposed grant to the International Commission of authority to prescribe for generic names a gender different from that grammatically appropriate where such action is needed in the interests of nomenclatorial stability; (5) determination of a gender for (*a*) generic names in the Class Aves having the termination -rhynchus; (*b*) generic names in the Order Decapoda (Cl. Crustacea) having the terminations -opsis and -gnathus; (*c*) for the following names—*Gigantorhynchus* Hamann, 1892 (Cl. Acanthocephala); *Desmognathus* Baird, 1850 (Cl. Amphibia); *Nephrops* Leach, [1814] (Cl. Crustacea, Order Decapoda); *Syngnathus* Linnaeus, 1758 (Cl. Pisces); (6) *Varuna* Milne Edwards, 1830 (Cl. Crustacea, Order Decapoda), validation of currently accepted gender for. Proposals are also made for the adoption of the following Declarations: (*a*) Article 21: clarification of the authorship to be attributed in certain circumstances to zoological names and to actions affecting the status of such names; (*b*) Article 25: clarification of the status of names published only in the indexes of books. Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Announcements

The fourth Coal Science Lecture of the British Coal Utilization Research Association is to be delivered by Sir Cyril Hinshelwood on October 19 at 5.30 p.m. in the lecture theatre of the Institution of Civil Engineers. He will speak on "The Carbon of Coal". Tickets are available from the Secretary of the Association (B.C.U.R.A., Randalls Road, Leatherhead, Surrey).

The Bedson Club, King's College, Newcastle upon Tyne, will be holding its hundredth lecture on October 26, when Prof. M. Calvin (University of California, Berkeley) will speak on "The Photosynthetic Carbon Cycle". Two further lectures will be given as follows: November 25, Prof. E. A. Guggenheim (University of Reading), "The Relation between Theory and Experiment in Physical Chemistry"; and January 27, Dr. F. Sanger (King's College, Cambridge), "The Chemistry of Insulin".

The Council of the International Union of Pure and Applied Chemistry has approved the recommendation of the Union's Commission on Nomenclature in Inorganic Chemistry that element 101 be named Mendelevium, symbol Mv. The original recommendation for this move was made at the eighteenth conference of the Union at Zurich during July 20–28, and was based on the claims of A. Ghiorso, B. G. Harvey, G. R. Choppin, S. G. Thompson and G. T. Seaborg, of the University of California, as announced in a report printed for the United States Atomic Energy Commission, *UCRL*-2943 (contract No. *W*-7405-eng-48), "The New Element Mendelevium", dated April 4, 1955.

Erratum. In *Nature* of August 27, p. 379, in the paragraph on super-voltage machines for X-ray therapy in the Science Museum, the misleading impression is given that betatrons and synchrotrons are widely used for hospital radiotherapy in Great Britain. They are, in fact, used for research purposes; for radiotherapy the travelling-wave linear electron-accelerator is being installed in a number of hospitals.

INTERNATIONAL UNION OF LEATHER CHEMISTS' SOCIETIES

FOURTH CONFERENCE

NEARLY four hundred members and guests from twenty-five countries took part in the fourth biennial conference of the International Union of Leather Chemists' Societies held in Stockholm during July 31–August 4. The official opening of the conference took place at the Kungl. Tekniska Högskolan, when in the presence of representatives from the Swedish Tanners' Federation, the Swedish Chemical Society and the University of Uppsala the president of the conference, Dr. K. H. Gustavson, called upon the veteran Swedish leather chemist, Dr. Edmund Stiasny, to declare the congress open. In the presidential address that followed, Dr. Gustavson dealt with the researches of the little-known Swedish chemist of the early nineteenth century, Carl Hyltén-Cavallius, who in the space of a short life of thirty-six years published several papers on tanning processes and also on the conversion of collagen to gelatin. His pioneer work did much to pave the way for subsequent investigations into mineral tannages.

There then followed the Max Bergmann Memorial Lecture delivered by his successor, Prof. Dr. Wo. Grassmann, of the Max Planck Institut für Eiweiss- u. Leder-Forschung in Regensburg. The subject, "Our Present Knowledge of Collagen", provided occasion for a comprehensive and lucid review of the progress of collagen research from the early days of Emil Fischer, through the work of Astbury to the modern concepts of the helical configuration proposed by Pauling and Corey. He also dealt with the many precursors and congeners of collagen that are now being widely investigated.

One novel feature of this congress was the holding of two symposia devoted to "The Properties of Leather" and "The Fundamentals of the Chemistry of Tanning Processes". In this way the organizers of the conference largely avoided one of the dangers that are apt to beset all large scientific meetings, namely, that of loading the programme with a host of unrelated papers. In these two symposia a number of invited speakers presented various aspects of the subjects which were afterwards discussed.

The symposium on "The Properties of Leather" included papers by Drs. R. G. Mitton (British Leather Manufacturers' Research Association and president of the Society of Leather Trades' Chemists), J. R. Kanagy (U.S. National Bureau of Standards), E. Baumann (Bally Experimental Station, Switzerland) and Prof. P. Chambard (École de Tannerie, Lyon). Mitton, in surveying the main physical properties of leather, emphasized the importance of the interfibrillary air spaces and showed how their relative magnitude affected such properties as water vapour and air transmission, thermal insulation, etc. Kanagy dealt mainly with the steps being taken in the United States by the government and by industry to establish standards by which the behaviour and reputation of leather could be safeguarded. Baumann presented the problem of leather properties from the point of view of the shoe-making industry and classified the desirable properties under three headings: (i) properties such as tear- and abrasion-resistance, and plasticity, that are important in manufacturing processes and in wear; (ii) properties such as flexibility of sole and upper leather and their permeability to water vapour, which are important for comfort; and (iii) properties such as colour stability, freedom from spue, etc., which are æsthetically important. Chambard's contribution mainly concerned methods of testing leathers in current use in France, such as sand-blast abrasion and the softening of leather in contact with water. He also outlined some recent service trials. Largely as a result of this symposium, it was agreed to set up an International Commission on Physical Testing of Leather, of which Dr. Mitton was invited to become chairman.

A whole day was devoted to the symposium on "The Fundamentals of the Chemistry of Tanning Processes", with lectures by Drs. K. G. A. Pankhurst (British Leather Manufacturers' Research Association), D. Balányi (Klippan), Th. White (Forestal Central Laboratories), A. Küntzel (Darmstadt), G. Otto (Badische Anilin- u. Soda-Fabrik), H. G. Turley (Rohm and Haas) and Mr. N. L. Holmes (R. Hodgson and Sons, Ltd.). Pankhurst outlined the work of his department on monolayer studies of tanning reactions and gave evidence of the predominant role of hydrogen bonding between phenolic groups in the tannin molecule and carbonyl groups in the protein 'backbone' in vegetable tanning. The use of model substances had provided confirmatory evidence of this. Otto, in a paper on the interaction of skin with aromatic tanning agents, dyestuffs and auxiliaries, also gave attention to this aspect and outlined the various types of chemical and physical linkage that could occur, from the strongest coulombic binding to the weakest van der Waals – London attractions. A review of the theories of vegetable tannage was given by White, who showed how modern concepts of the collagen molecule have helped in the interpretation of vegetable tanning processes. Küntzel's contribution, which was concerned with synthetic tannages, showed how modern syntan manufacturers had tended to depart from the original object of simulating vegetable tannins, having realized the immense versatility that could be achieved by concentrating on ionic types. Balányi gave a very full summary of the chemistry of chrome compounds and their reaction with hide. The papers of Holmes and Turley were essentially practical, the former dealing with modern sole leather manufacture, and the latter tracing the influence of the pre-tanning processes on the final properties of the leather. Prof. D. Burton provided a concluding résumé.

In addition to the papers presented at these two symposia, fifteen other communications were read. It is impossible to summarize all these here, but mention may be made of the following, which provoked some useful discussion. In "Studies of Leather by means of a Sonic Technique", J. R. Kanagy and M. Robinson described the propagation of sound waves through various types of leather in different directions, showing that the velocity of the waves is correlated with such physical properties as tensile strength. R. G. Mitton, in "The Diffusion of Water Vapour in Leather", provided conclusive proof that the transfer process is almost exclusively by diffusion

through the interfibrillary air spaces and that diffusion through the fibres themselves is negligible. In "Tanning as a Rate Process", N. L. Holmes and H. G. Wollenberg described the use of buoyancy measurements for following the uptake of tannin by skin. Equilibrium values agreed well with chemical analysis. The uptake was exponential, with half-periods varying from several days with dilute solutions to 18 hr. for strong solutions. "The Examination of the Fastness Properties of Leather Dyestuffs", by W. Weber, put forward a proposal, eventually agreed in a plenary session of the conference, that an international commission be set up to co-ordinate the activities of the various national committees interested in this subject. Other papers dealing with dyeing were: "The Colouring of Suede Leather" (C. Alabouvette and C. Rouanet) and "The Measurement of the Colour of Leather" (J. A. Sagoschen). The problem of effluent disposal, which is becoming increasingly pressing in the leather industry, was discussed in two papers: "The Problem of Sewage in the Leather Industry" (H. Scholz) and "Financing Waste Disposal Installations" (E. B. Thorstensen). The impregnation of sole leather with synthetic resins, with the view of improving wearing properties, was discussed by P. Chambard.

In addition to the scientific and technological communications, useful committee work was carried out by the two existing International Commissions dealing with Leather Analysis and Tannin Analysis.

Social events included a visit to Skansen, where a replica of an ancient tannery and of many other craftsmen's shops attracted much attention, a sea trip to part of the Stockholm Archipelago, a reception by the Stockholm City Council and the closing banquet in the famous Gyllene Salen of the City Hall.

The conference attracted a good deal of attention in Stockholm, and besides the usual news conferences, Radio-Tjänst relayed an account of the proceedings given by the retiring president, Dr. K. H. Gustavson, and his successor, Dr. H. G. Turley. At the final meeting of the conference it was decided to accept the invitation of the Italian Society of Leather Trades' Chemists to hold the 1957 Conference in Rome.

K. G. A. Pankhurst

CANADIAN COLLOQUIUM ON THEORETICAL PHYSICS

A COLLOQUIUM on theoretical physics was held at the Canadian National Research Council, Ottawa, during June 9–17, arranged by the Division of Pure Physics of the Council in honour of Prof. P. A. M. Dirac. Owing to a prolonged illness, Prof. Dirac was unable to attend the colloquium, but he was to visit the National Research Council later. The colloquium was attended by a hundred and twenty-one physicists from Canada and forty-one from the United States. At the opening session, Dr. E. W. R. Steacie, president of the National Research Council, welcomed the speakers and visitors, and Dr. G. Herzberg, director of the Division of Pure Physics, explained the general scope and purpose of the colloquium; he said that there would be twenty-one invited papers and twenty-four contributed papers covering a wide range of subjects in theoretical physics, and he hoped that sufficient time would be available for the speakers to give an account of their subjects which would be of value both to the non-specialists and to the specialists. This purpose was admirably achieved, and the colloquium was a valuable contribution both to theoretical physics in general and, more particularly, to physics in Canada.

The opening lecture was the first of three lectures by H. A. Bethe on the scattering of π-mesons. Dr. Bethe gave an account of the experimental evidence and showed how the main properties of the meson–nucleon system could be deduced. The dominance of the $p_{3/2}$ state in π-meson scattering and the energy dependence and sign of the principal phase shifts were shown to follow from the scattering data independent of any perturbation method or detailed use of theory. His second talk gave an account of Goldberger's proof based on causality that the real part of the forward-scattering amplitude changes sign at a resonance, and then described the successes of the Chew–Low theory of meson scattering, and of the Cornell calculations based on the Tamm–Dancoff equation. Dr. Bethe's third talk gave Wick's derivation of the Low equation in meson theory and noted that Low and Chew had now shown that this equation followed from causality rather than from any detailed structure of meson theory.

S. Chandrasekhar gave a series of five lectures on problems of stability and turbulence in hydrodynamics and hydromagnetics. In his lectures on stability he concentrated principally on the manner of the onset of thermal instability in a layer of fluid heated below when it is subject to rotation and/or a magnetic field. He showed that, when subject to rotation, instability can set in either as convection and a stationary pattern of motions, or as overstability and a purely oscillatory pattern of motions, depending on the ratio K/ν of the thermometric conductivity to kinematic viscosity. The dependence on this ratio is such that, for a layer of water subject to rotation, instability should set in as ordinary convection, while for mercury it should set in as oscillations of increasing amplitude. In these instances the experiments by D. Fultz and Y. Nakagawa confirm all aspects of the theoretical predictions. Similarly, Prof. Chandrasekhar showed that an external magnetic field should inhibit the onset of convection by thermal instability in an electrically conducting fluid such as mercury; and that the extent of the inhibition should depend on the strength of the impressed magnetic field and the electrical conductivity in a determinate way. Here again the theoretical predictions have been confirmed by experiments. In his lectures on turbulence, Prof. Chandrasekhar described his recent efforts to develop a deductive theory of turbulence. He suggested that the similarity principles of Kolmogoroff (and their extensions) provide boundary conditions at infinity for the basic equations he has derived (*Proc. Roy. Soc.*, **229**, 1 (1955), equation 32). In this way he has been able to determine in a unique manner the function and the constant which are left unspecified by the dimensional arguments. In his last lecture he outlined an elementary theory of hydromagnetic turbulence and showed that two distinct modes of turbulence exist. He distinguished these as the velocity mode and the magnetic mode, respectively. In both modes, equipartition between the two forms of energy (kinetic and magnetic) prevail among the largest eddies present; however, in the velocity

mode the magnetic energy (relative to the kinetic energy) tends to zero in the small-scale Fourier components, whereas in the magnetic mode the magnetic energy tends to about two and a half times the kinetic energy. He described the bearing of these results on the possible character of the interstellar magnetic field and on Fermi's ideas on the origin of the cosmic rays.

Collective motion in nuclei and nuclear moments was discussed by G. M. Volkoff in two lectures, the first of which described the main ideas of the Bohr–Mottelson model of the nucleus. In his second lecture, Dr. Volkoff referred to recent work at the Massachusetts Institute of Technology and at Columbia University on nuclear magnetic octopole moments, and indicated briefly some features of the Bohr–Mottelson model relevant to nuclear moments. He concluded with an outline of the nuclear moment aspects of the work of his own research group at the University of British Columbia on radio-frequency spectra of nuclei in crystals, which has been reported in a series of papers in the *Canadian Journal of Physics*. In particular, a new method of measuring nuclear spin was described.

W. H. Watson gave a review of the experimental work on mechanical properties of helium II carried out at the University of Toronto and discussed their interpretation on the two-fluid theory. He pointed out that a hydrodynamical explanation cannot be given for the experimental results for the viscosity measured by the rotating cylinder method and for the relation of the zero shift of the inner cylinder, and he suggested that a better understanding of the kinetic theory of classical liquids would promote our understanding of the behaviour of a quantum liquid like helium II.

A description of the many-body problem in nuclear structure was given by R. J. Eden, the account being based on recent work by Brueckner and others at Indiana University. The simplicity of certain nuclear models gives hope that corresponding simple features can be derived by considering a system of many nucleons in strong interaction. The many-body method was illustrated by applications to the problem of nuclear saturation and to the theory of low-energy neutron reactions with nuclei.

G. Breit gave three lectures on nucleon–nucleon scattering. The first of these gave a historical survey of the subject and explained the general features of the experimental evidence and its mathematical interpretation in terms of partial waves and phase shifts. It was shown that a careful analysis of experiments at low energy is insufficient to determine the nucleon–nucleon potential, and it was indicated how high-energy data can be interpreted by a boundary condition which corresponds to a repulsive core potential between nucleons. In his second lecture, Dr. Breit discussed the limitations of potential theory in nucleon–nucleon scattering, and he described difficulties which arise when one tries to interpret meson field effects in a wave equation. Dr. Breit's third lecture was primarily concerned with high-energy data; he discussed the successes and failures of various potentials in the high-energy region and indicated the importance of relating the data for pion–nucleon and nucleon–nucleon interactions.

G. Wentzel gave two lectures on hyperon–nucleon interactions and one on rotational states of deformed nuclei. His first lecture classified the experimental information on hyperons by interpreting it in terms of their masses, spins, isotopic spins, and decay schemes. He showed that the Q-values indicate that very strong selection rules must operate to slow down the decay of hyperons, and described Gell-Mann's interpretation of the data by isotopic spin-selection rules. In his second lecture, Dr. Wentzel showed how some information can be deduced about Λ^0 if one assumes that the observed binding in a hyper-fragment comes about by coupling to nucleons via θ-particles. In his lecture on deformed nuclei, he considered the discrepancy between nuclear distortion deduced from quadrupole moments and rotational energy-levels using the Bohr–Mottelson theory. He concluded that this discrepancy cannot be removed by refining calculations and that the theory, in its present form, is untenable.

V. F. Weisskopf lectured on nuclear reactions, on the shell theory of deformed nuclei and on the proton–neutron mass difference. His first lecture described the relation between the resonance fine-structure for low-energy neutron reactions with nuclei and the broad structure obtained by averaging over resonances. It was shown that the latter can be described by neutron scattering on a complex potential having a mean absorption similar to that of a neutron in a Fermi gas. In a discussion of detailed reaction cross-sections, significant departures from the statistical theory of Niels Bohr were noted, particularly in the medium-energy range. Dr. Weisskopf's second topic was an account of the work of K. Gottfried at the Massachusetts Institute of Technology, who has calculated the ground-state energies of a deformed independent particle model of nuclei. These predict a distortion giving a minimum energy for each nucleus which agrees well with observed quadrupole moments. Dr. Weisskopf's third talk described the work of Feynman and Speisman on the electromagnetic origin of the proton–neutron mass difference and showed how an analogous mass difference also exists in a classical theory.

In addition to the invited papers described above, papers were contributed covering topics ranging from the Dirac equation in Finsler space to thermal conduction in solids. These papers were read by P. Havas and C. R. Mehl, F. A. Kaempffer, R. H. Good, C. O. Hines, H. Jehle, H. Feshbach and E. Lomon, I. Kay and H. E. Moses, D. K. C. MacDonald, Y. Takahashi, R. J. Eden, D. R. Inglis, U. Ingard and D. C. Pridmore-Brown, A. B. Bhatia, S. Gasiorowicz, R. Jastrow, H. Yilmaz, F. R. Tangherlini, F. H. J. Cornish, A. E. S. Green and K. Lee, T. Y. Wu, S. Shanmugadhasan, T. F. Morris, A. Klein, and O. Theimer. After a dinner on June 16, given by the Royal Society of Canada, Dr. D. C. Rose gave a talk on the recent cosmic-ray expedition to the Arctic and Antarctic of members of the National Research Council.

The colloquium was the first of its kind in Canada, and, judging from the comments of the principal speakers and other visitors, it was both enjoyable and useful. The distinction of the visitors from the United States indicated the great interest of American scientists in Canadian physics, and it should perhaps be noted that a fault of the meeting was the small number of papers read by Canadians. It is to be hoped that the success of the colloquium will encourage the organizers to provide further opportunities for Canadian theoretical physicists, usually so widely dispersed, to gather together and talk with each other and with visitors from the United States and elsewhere.

R. J. Eden

LOCUST RESEARCH

DISCUSSIONS IN LONDON

IT became apparent early this year that a number of workers engaged on locust research abroad would be on leave in England during the summer, and the Anti-Locust Research Centre, taking advantage of this fact, organized a series of informal discussions on various aspects of current research. It may be taken as an indication of the magnitude of the locust problem, and of the importance now attached to it all over the world, that from such a modest beginning grew the virtually international meetings on locust research held in London during July 18–23 in the rooms of the Royal Meteorological Society. Locust workers attended from Canada, Cyprus, East Africa, France, French Sudan, Israel, Jugoslavia, Northern Rhodesia, South Africa and Syria, and they included representatives from the survey and control organizations concerned with the major locust pests of Africa and the Middle East, namely, the desert locust, the red locust, the African migratory locust, the brown locust and the Moroccan locust. Universities and other institutions in the United Kingdom where research on locusts or related problems is conducted were also well represented.

The keynote of the meetings was informality, and although the period of fifteen minutes allotted to each speaker was too short to allow of more than a brief outline of current problems and research, the good chairmanship shown at all sessions ensured that the maximum amount of factual evidence was put before the meeting in order to provoke discussion. That this was stimulating to all was shown by the fact that almost every person who attended spoke at least once.

The meetings were arranged as a series of sessions each relating to a particular aspect of locust research. The first session, on "Aggregation and Gregarious Behaviour", was marked by the presentation of evidence which allowed gregariousness to be approached on a quantitative basis instead of by the rather vague qualitative methods used hitherto. R. C. Rainey (Desert Locust Survey), Z. Waloff (Anti-Locust Research Centre) and H. J. Sayer (Desert Locust Survey) showed that in spite of random flight orientation, and also of convective turbulence in the air and the dispersal to be expected from wind, swarms of the desert locust traverse hundreds of miles as discrete entities. They have been led by these observations to postulate reactions having the effect of keeping the swarm together, and have observed various behaviour patterns in flying swarms which may have been relevant. P. T. Haskell (Imperial College, London) spoke on the possible sensory mechanisms related to gregarious behaviour, with particular reference to auditory and visual reactions. P. E. Ellis (Anti-Locust Research Centre), W. J. Stower (Desert Locust Survey) and G. B. Popov (Desert Locust Survey) spoke on aggregation in hopper bands and in ovipositing swarms of the desert locust. It was most interesting to hear from L. D. Vesey-Fitzgerald (International Red Locust Control Service) a preliminary theory relating outbreak areas to vegetation pattern in the case of the red locust.

The second session, with Prof. O. W. Richards (Imperial College, London) in the chair, consisted of papers on the "Estimation of Numbers". J. G. Skellam (Nature Conservancy) and D. L. Gunn (International Red Locust Control Service) spoke about estimations of populations of the red locust, the latter dealing with the figures obtained by the practical method of flushing the insects by means of a motor vehicle. Z. Waloff and R. C. Rainey dealt respectively with numbers in solitary populations and in swarms. J. P. Dempster (Moroccan Locust Research Team) spoke on estimation of populations of various stages of the Moroccan locust, and W. J. Stower and C. Ashall (Desert Locust Survey) on estimations of hopper bands of the desert locust. The latter gave figures showing estimates of the number of hoppers in bands based on experienced visual observation and on various other techniques, and it was interesting to find that the former gave far more accurate results; unfortunately, it is not a teachable technique. G. Popov spoke on egg-pod distribution, a problem which is complicated by the fact that often the extent of the egg-field is difficult to establish. One important point made in the discussion was that the accuracy desired depends on the purpose for which the estimate is required; for control campaigns, figures relating to orders of magnitude of populations are generally sufficient, enabling fairly quick practical methods to be used, but for research, more accurate methods must be found.

The subject of the third session, "Factors in the Fluctuations of Populations", followed naturally that of the preceding one, and M. J. Richards (Anti-Locust Research Centre) and N. Waloff (Imperial College, London) gave papers on the fecundity and fertility of various Orthoptera under laboratory and field conditions; these papers focused attention on the great gaps in our knowledge relating the effect of environment and the physiological state of the insect to its reproductive capacity. J. P. Dempster spoke on variations in a population of the Moroccan locust relative to the changing habitat. No more than a start has been made in studying natural enemies of the desert locust (D. J. Greathead, Anti-Locust Research Centre) and other factors of natural mortality in this species (J. Roffey, Desert Locust Survey).

The session on "The Distribution and Movements of Populations", with P. R. Stephenson (Desert Locust Survey) in the chair, was marked by the interesting papers relating to movements of scattered populations presented by J. T. Davey (International African Migratory Locust Control Organization) for the migratory locust and by Z. Waloff for the desert locust. The former outlined experimental work which suggests a closed-circuit migration by night related to the seasonal rains and floods in the Niger Basin; although there were criticisms of some of the inferences on physiological grounds, nevertheless the theory is most attractive in explaining the appearance of hopper bands in approximately the same parts of the region year after year and the cyclical changes in population densities that occur over parts of the area. The results presented by Z. Waloff demonstrated that movement of scattered adults of the desert locust occurs at night. R. C. Rainey and Z. Waloff spoke on the theory that swarms of the desert locust move down-wind towards zones of convergence of air flow; this conception has the virtue of explaining the observed displacements of flying swarms and the general migration cycle demonstrated by swarm mapping. Again, some aspects of the theory were challenged, and it clearly needs much more work before it can be accepted as a complete basis for the movement of swarms, but no alternative theories

were offered. The papers of P. E. Ellis and W. J. Stower on movements of hopper bands of the desert locust showed that there may be some common features in the behaviour of adults and that of hoppers.

A session on "Locust Phases" began with a review by J. S. Kennedy (Cambridge) of the recent approaches to the problem with emphasis on the endocrinological and behavioural aspects of phase variation. Papers by F. O. Albrecht (Laboratoire de Biologie Animale, Paris), P. E. Ellis and P. Hunter-Jones (Anti-Locust Research Centre) illustrated the great amount of laboratory work that is being done on many aspects of the biology, morphology, physiology and behaviour of the phases. Perhaps the greatest need suggested by these papers and the subsequent discussion of them is for basic physiological knowledge to link together the results of widely separated experimental approaches to the problem. R. E. Blackith (Imperial College, London) and D. E. Davies (Anti-Locust Research Centre) spoke on the application of statistical methods, in particular the generalized-distance method, to the analysis of phase variation in locust populations.

The research that is being done on control methods was described and discussed under the heading "Control Development", with Dr. D. L. Gunn (International Red Locust Control Service) in the chair. It ranges from field investigation of the use of aircraft against swarms, hopper bands and egg-fields to laboratory work on problems such as the cumulative effect of sub-lethal doses of insecticides, the comparative toxicity of different materials and formulations, and the comparative susceptibility of species and stages of locusts. The principal speakers included R. D. MacCuaig (Anti-Locust Research Centre) and J. H. Lloyd (International Red Locust Control Service), the former dealing with laboratory research and the latter with the various methods, including spraying adult locusts from light aircraft, used for controlling the red locust in its outbreak areas near Lake Tanganyika.

Papers by Z. Waloff, R. Skaf (Syria), R. C. Rainey, G. B. Popov and W. J. Stower, on "The Desert Locust Problem", emphasized a fact suggested at many of the previous talks, that the desert locust remains the most difficult of the plague locusts from the point of view of both research and control. The lack of clearly definable outbreak areas, the very long-range migrations of which the insect is capable, the possibility of continued nomadic existence of swarms in small numbers during interplague periods, and the large number and diversity of countries affected by it, all conspire to complicate the problem, but also to make it most challenging to research workers. B. Zolotarevsky (International African Migratory Locust Control Organization) spoke on some unusual seasonal movements of swarms of the desert locust in West Africa.

The final session, on "Trends and Needs in Locust Research", was introduced by T. H. C. Taylor (Anti-Locust Research Centre) in a talk designed to illustrate the gaps in present-day knowledge revealed by the preceding sessions. In the discussion which followed, two main trends were apparent. These were, on one hand, a call for more physiological research relating to sensory physiology, internal physiological states and the relation of such states to behaviour and to phases; and on the other hand, the treatment of the problem quantitatively from the point of view of population dynamics and ecology.

This gathering was the first for which locust research workers assembled solely to exchange views and discuss current work, previous locust conferences having been largely concerned with matters of international co-operation and control arrangements. Its success was undoubtedly due to the informal atmosphere, which encouraged the airing of unconventional and tentative proposals, and thus helped to enliven the discussions. Perhaps the emergence of several tentative and controversial theories may reduce the empiricism which has perforce formed such a large part of locust research hitherto. The Anti-Locust Research Centre, under its director, Dr. B. P. Uvarov, who took the chair at most of the sessions, is to be congratulated on initiating this stimulating review of current research on locusts.

P. T. HASKELL

COLONIAL STUDENTS IN GREAT BRITAIN

THE inquiry conducted by Political and Economic Planning (PEP) into Colonial students in Great Britain* had as its practical aim to discover whether any changes in approach or organization on the part of the authorities concerned might lead to a more effective use of the resources devoted to the education and training of men and women from the Colonial territories, and to make constructive suggestions where necessary. The general implications have been discussed elsewhere in *Nature*, but the inquiry, supplemented by questionnaire, interview and field work, and the detailed information about scholarship holders kept by the Colonial Office, brought to light concrete facts and figures which are not otherwise easily available. These facts, on which the main recommendations are based, are presented in one chapter of the report and in the appendixes, and in their collection PEP was guided by four main considerations: the interest which the student or his sponsors has in the use to be made of his education; the possible wish for him to acquire more than a qualification or purely professional skill; the requirements of the society from which the student comes; and the effect which the education of Colonial students in Britain may have upon relations between Britain and the Colonial territories.

The grand total of Colonial students in the United Kingdom and the Republic of Ireland on January 1, 1955, was 10,200, but this includes 2,040 student nurses who are otherwise excluded from these statistics. In 1939 there were about four hundred Colonial students at British universities with an unknown number at other institutions. Ten years later the combined total was 3,300, of whom 1,745 were university students. For the academic year 1954–55, there were 8,160 students, of whom 2,915 were university students; but although in 1953 nearly a tenth of university students in Britain were overseas students, only one-fifth of these, or about 2 per cent of the total, were from the Colonial territories. While, however, the number of university students in Britain is slightly decreasing, the number of students coming from the Colonial territories is increasing, and, since 1950, the number of post-graduate Colonial students has become significant. During the academic year 1954–55 nearly one-third

* Colonial Students in Britain: a Report by PEP. Pp. ix+257. (London: Political and Economic Planning, 1955.) 21*s*.

of Colonial students in Britain were Nigerians, about one-tenth came from the Gold Coast, and a small group from Sierra Leone and Gambia. More than one-fifth came from the Far East—Malaya, Singapore, Hong Kong, Sarawak and North Borneo—about one-eighth from East and Central Africa, and another eighth from the West Indies, the remaining one-tenth coming from Cyprus, Malta, Gibraltar, Mauritius, Fiji, the Seychelles and the other Colonies of the British Commonwealth. Every Colony has to-day more students in Britain than it had six years ago, but since 1949 Nigeria has replaced the West Indies as the largest single group and, with the Far East territories, has outstripped all the others in the rate of growth.

By far the greatest number of Colonial students who go abroad from their homeland go to the United Kingdom, but many go to other Commonwealth countries, including India, Australia, New Zealand and Canada. The last-named has more than six hundred Colonial students in its universities, and more than four hundred Nigerians are now studying in the United States. Some have gone to the Netherlands, and the Gold Coast Cocoa Marketing Board in 1953–54 placed about forty medical students in Germany. Colonial students are mostly older than their British fellow-students, usually between twenty and thirty, about 10 per cent of those interviewed being thirty-one years of age or more; most African students are between twenty-five and thirty. About a quarter of those interviewed were married, and nearly half of them had their wives or husbands with them in Britain; these figures are regarded as typical. About one-half had reached School Certificate standard, a quarter had taken Higher Certificate, an Intermediate degree or a first M.B.; about one-twentieth had graduated, and one-tenth had some form of professional or trade qualification. The gap between the date of their last examination at home and the commencement of their studies in Britain is often considerable, sometimes several years. About one-third of the Colonial students hold scholarships, although the proportion is much smaller than in 1949. For Gold Coast students the proportion in the academic year 1954–55 was two-fifths.

Scholars outnumber private Colonial students in agriculture, forestry, veterinary science, education, teaching diploma, social sciences, public administration, railway training and Post Office training courses, and they account for about a third of those taking architecture, medicine, pharmacy, printing and science. Three-quarters of all Colonial students take one of eight courses: law (18 per cent); engineering (14 per cent); medicine (12 per cent); allied medical subjects like dentistry (3 per cent); arts subjects (6 per cent); preliminary studies to qualify for the desired course (10 per cent); education and teacher training (10 per cent); and science (5 per cent). The largest group (law) has 1,451 students, and the smallest (science) 378. Except for nursing, law is the course with the largest number of registrations, but although a much higher proportion of West Africans study law at a university than of any other group of Colonial students, there are, relative to their numbers, fewer West Africans at the Inns of Court than any other group. The percentage of Colonial students who take a further degree appears to be slightly higher than that of British students. Little is known about the part-time students (probably several hundred in number); but the inquiry suggests that, while this group occasionally throws up a first-rate scholar, such students generally experience great difficulties with their studies and sometimes lose heart and abandon them. Just over a third of Colonial students are at universities and university colleges, about one-eighth are at the Inns of Court, and the rest mainly at polytechnics, and technical and training colleges. In 1955 more than a half were in London, only about 3 per cent at Oxford and Cambridge, about 27 per cent in the English provinces, 7 per cent in Scotland, 2 per cent in Wales and 7 per cent in Northern Ireland and the Republic of Ireland. Most of the women are student nurses; but excluding nurses, women students constitute just over one-sixth of all Colonial students, and about one-third are at universities.

COMMONWEALTH OBSERVATORY, CANBERRA

REPORT FOR 1954

THE report for 1954 of the Commonwealth Observatory, Canberra*, follows the usual course, dealing with the work of the Observatory under eleven main headings, the first of which includes time service and positional astronomy, described under five sub-sections. Time signals were sent out from the Observatory four times each day, the average correction for the transmitted signal being 21 m.sec. and the average daily change in these corrections 2·2 m.sec. Under astrophysical investigations are included magnitude sequences, variable stars, nebulæ and clusters, stellar atmospheres, stellar spectroscopy and Mars. With regard to nebulæ and clusters, it is announced that the photographic survey of both the Magellanic Clouds has been completed with an Ektar camera. Star counts in and around the Small Cloud to magnitude 14 and 16 provide new evidence on the structure and population characteristics of the Cloud. It has been established that the cepheids in the Large Cloud, as in the Small Cloud, are much bluer than the galactic cepheids. The survey of bright southern galaxies with the Reynolds reflector is about 90 per cent complete and about 110 plates were obtained on twenty-eight nights, bringing the total to 270, of which 170 have been measured for types and diameters, and a few for luminosity distribution in some large spirals.

Under the heading of telescopes and equipment, it is satisfactory to know that the major components of the 74-in. reflector have been erected, the final assembly only awaiting the completion of the dome which, with the optical parts, arrived early in the year. The erection of the Yale–Columbia 26-in. refractor has been commenced and will be completed as soon as the dome is finished. The old clock-drive will be replaced by an electronic diurnal drive, and provision has been made for a Selsyn repeater which will indicate declination settings to 2′ of arc. The Munich zenith telescope, installed in May, has since been in constant use by the Munich observers. An iris diaphragm photometer is in operation, and preliminary trials are being made on plates obtained with the Zeiss instrument.

In the account of buildings, it is mentioned that the assembly for the 74-in. and Yale–Columbia

* Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1954. Pp. 8. (Canberra: Commonwealth Observatory, 1955.)

telescopes, which was commenced during the year, is now nearing completion, but unfortunately the 50-in. dome, although new, has given a lot of trouble, and substantial improvements will be made. The figuring of the aspherical secondary for the 50-in reflector was successfully achieved in the optical shop, and this will enable the telescope to be used as a Gregorian instrument for stellar spectroscopy prior to its conversion to a Schmidt type; preliminary work for this purpose has already been carried out on a 36-in. corrector plate. Under the heading of ionospheric prediction services, reference is made to the extension and completion in some sections of the atmospheric dynamo theory. An investigation of oblique incidence propagation has been commenced by recording field strengths of inter-station communication equipment. A report has been prepared on the investigation of triple splitting, which provides new information on the mechanism of 'Spread *F*' ionospheric echoes at high latitudes. Work has been carried out on *Z* echoes.

Among the reports on liaison with other observatories may be mentioned the use of the Reynolds reflector for about a quarter of the time by the Yale–Columbia observer for the completion of a survey of the brighter southern galaxies. The Munich observers, Drs. Schmiedler and Heintz, have been working since May on a programme of absolute declinations of *FK*3 stars, and, in addition, Dr. Heintz has collaborated with the Observatory staff members in working with the slit spectrograph and also with the Farnham slitless spectrograph.

Two research scholars and one instrument-maker are attached to the Observatory, and one of the scholars, Dr. A. Przybylski, received the Ph.D. of the Australian National University (where the Commonwealth Astronomer has continued to act as honorary professor of astronomy), which was the first such degree to be awarded. Prof. O. Struve, during a short visit to Australia, spent two weeks at the Observatory, holding a number of valuable discussions, chiefly on spectroscopic problems, with members of the staff. He also presided at a symposium in Canberra at which three members of the staff presented papers under the title "Structure and Composition of the Galaxy".

STRUCTURE OF COLLAGEN

By Prof. G. N. RAMACHANDRAN and Dr. GOPINATH KARTHA
Department of Physics, University of Madras, Madras 25

A STRUCTURE was proposed for collagen by us about a year ago[1]. Although it explains the features of the infra-red spectrum and the chemical composition of collagen, it appears to be defective in that it disagrees with the X-ray data for stretched collagen[2] and in having too large an angle between the NH and N . . . O directions in hydrogen bonds (Pauling, L., personal communication). It is found that a small modification of the earlier structure, which preserves many of its features, fits the above evidence on collagen quite well. In addition, it also explains a number of other properties of collagen, in particular, the important role of hydroxyproline in this protein and the periodicity of 640 A. along the fibre axis.

The new structure (the projection of which along the fibre axis is shown in Fig. 1) is topologically very similar to the earlier one in that it consists of triple chains of amino-acid residues, each chain being itself a helix. However, the chains now form coiled coils, instead of being arranged with their axes parallel to the fibre axis. Thus, every third α-carbon atom (corresponding to the *G*-type of carbon atom of the earlier structure) is placed on the surface of a cylinder of radius 1·0 A., the successive ones being displaced (in unstretched collagen) by 8·58 A. along the axis of the cylinder and rotated through an angle of 36° about the axis. The single coiled coil repeats itself after thirty residues, and the repeat distance along the fibre axis is 85·8 A. The two other chains occur in such a manner that the three chains are symmetrically disposed with respect to one another. Their configuration is most easily described by saying that they are displaced along the fibre axis by + 28·6 A. and − 28·6 A. with respect to the first chain. They are also related to the latter by a rotation of ± 108° about the axis of the cylinder and a translation of ± 2·86 A. parallel to the axis. For the mathematical discussion of the structure, each chain may be described as consisting of a minor helix (following the nomenclature of Crick[3]) having ten residues in three turns, with a projection of 2·91 A. per residue along its axis, wound to form a major helix of radius 2·5 A., there being thirty residues per turn of the major helix. The major

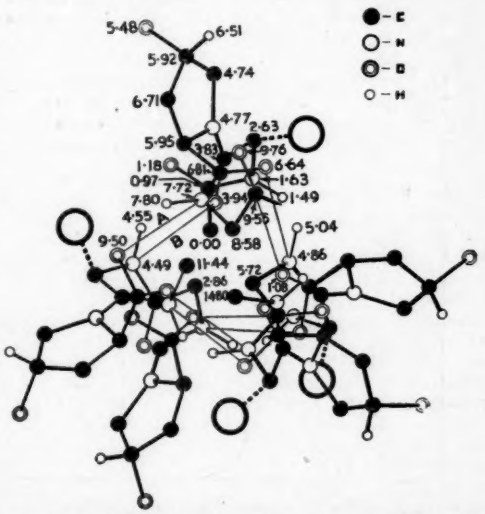

Fig. 1. Projection of the proposed structure along the fibre axis. The numbers denote the heights of the atoms above the plane of projection. Only a part of each of the three individual chains is shown. The thin lines indicate the N . . . O directions in the hydrogen bonds

helix is wound in a direction opposite to that of the minor helix, the latter being a left-handed screw if all the residues are of the *L*-type. Thus, while the thirty residues make nine turns in the co-ordinate system of the minor helix, they make ten turns in the fixed co-ordinate system of the major helix; this ensures that every third residue is similarly situated with respect to the fibre axis.

Because of the above relationships, there are only two types of inter-chain hydrogen bonds, marked *A* and *B* in Fig. 1, which are repeated by screw symmetry. In both bonds, the N . . . O distance is close to 2·9 A. and the angle between NH and N . . . O directions is about 30°. This angle would be less if the NH-bond were not coplanar with the rest of the amino-acid residue.

As in the earlier structure, two of every three NH groups are hydrogen bonded to an O of a CO group, but unlike it, the two oxygens to which they are linked are different. Thus, of every three carbonyl oxygens, only one does not take part in internal hydrogen bonding in the triple-chain cylindrical rods. This oxygen points outward from the rod and plays an important part in the cross-linking of the rods by side-chains, as shown below. As before, every third residue must be a glycine residue, and similarly a maximum of one-third of the residues may be proline or hydroxyproline.

The essential difference introduced in the structure, so far as its X-ray pattern is concerned, is that the 2·86 A. reflexion is meridional, and is the only meridional reflexion apart from its higher orders. Further, the exact repetitive unit along the fibres axis is ten residues (28·6 A.), which agrees well with the observed layer-line spacings[4]. The intensity distribution among the spots on the layer lines has been found to agree with the structure qualitatively. The distribution of intensity along the equator has been worked out in detail and is shown in Fig. 2. This is in good agreement with observations (Ramachandran, G. N., and Ambady, G. K., unpublished results), particularly with regard to the large peak at 4·7 A. and the minimum at 7·4 A. The absence of the expected spot at 7 A. is thus explained. In wet collagen, the water would be expected to occur between the cylindrical rods and, under these conditions, the minimum shifts towards smaller angles and continues to occur in the region of the unobserved reflexion of 7–8·5 A., even though the lattice expands. Further, the three-dimensional

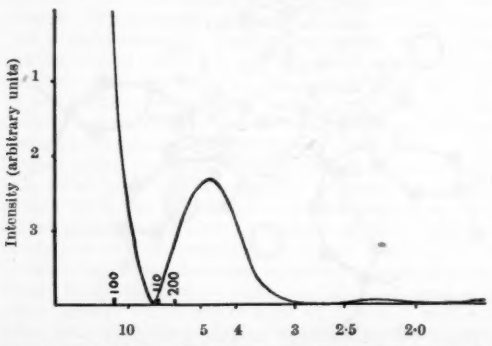

Fig. 2. Radial intensity distribution along the equator calculated from the structure. The abscissæ are proportional to the reciprocal of the spacing. The positions corresponding to the 100, 110 and 200 reflexions of the hexagonal unit cell with $a = 12$ A. are also marked

cylindrical Patterson diagram for collagen published recently by Yakel and Schatz[5] is in excellent agreement with the structure. The peak at about 1 A. in the level $z = 0$ is due to the projected component of bonds joining neighbouring atoms perpendicular to the fibre axis; that at 2·7 A. is due to the component of the almost horizontal hydrogen bond interactions; the strong one at 4·5 A. is due to the distances between the three approximately parallel amino-acid residues at the same level.

The recent infra-red data[6] of Sutherland *et al.* are also in agreement with the present structure. The expected dichroism of the non-coiled 3–10 helix agrees with the observed data[7], and the further coiling of this helix produces only small changes and the results are not materially different.

The distribution of the proline and hydroxyproline rings can be calculated exactly, and they are found to be such that the oxygen of hydroxyproline is nearly as far away from the axis of the cylinder as is possible. Thus internal hydrogen bonding of the OH in hydroxyproline is ruled out. Rather, these groups take part in linking the cylindrical rods with one another; the hydroxyproline OH group in one rod is nearly at the same level as the exposed non-hydrogen-bonded carbonyl oxygen of the neighbouring rod, so that they could readily be linked by a hydrogen bond. This is in agreement with the results of Gustavson[8] on the nature of the hydroxyproline OH . . . O bond. Assuming these bonds are 2·7 A. long, the distance between the centres of neighbouring rods works out to be 11·6 A., which is close to 12 A. (10·4/0·866) found for well-dried collagen[9]. The theoretical value is not precise, for it would change if the bond angles in the amino-acid residue and the α-carbon atoms are altered by even a small amount.

If the coiled coils described above are simply put together in a hexagonal array, then only some of the hydroxyproline OH groups are bonded to carbonyl oxygens of neighbouring rods. However, it is found that a very slight change in the pitch of the major helix is sufficient to make the number of hydroxyproline–carbonyl hydrogen bonds a maximum. Instead of a rotation angle (say φ) of 36° per three residues about the axis of the major helix, the angle must be changed to 35°. This immediately introduces a 6_1 symmetry for the major helix, which now repeats after 216 residues (618 A.). The spacing 618 A. is highly suggestive of the 640 A. spacing found in the small-angle X-ray pattern and in electron micrographs of collagen. The condition for stabilization of the structure by forming the maximum number of hydroxyproline cross-links thus automatically leads to the long spacing of collagen. Further, on working out the number of hydroxyproline residues which occur in such a position that the hydrogen bonds are fairly short, the number is found to be twelve for every thirty-six of the *P* type residues. The percentage of hydroxyproline residues occurring in collagen is variable with the source of the material[8]; but if we assume that the hydroxyproline residues which actually occur are all hydrogen-bonded, then the maximum proportion of hydroxyproline residues should be 11 per cent. It is noteworthy that the maximum observed (namely, in bovine collagen) is about 10 per cent. Further, the correlation of the shrinkage temperature with hydroxyproline content reported by Gustavson[8] is also to be expected if hydroxyproline is mainly responsible for the cross-linking of the cylindrical rods. When collagen shrinks, the individual chains

in the triple chain are not likely to be separated, but the triple chain itself would take up a highly folded configuration. The X-ray pattern of gelatin, in fact, supports this. The detailed evidence will be discussed elsewhere.

Having fixed the configuration of the rods with reference to hydroxyproline cross-linkages, a consideration of the length of the *R* side-chain of the third residue needed to form hydrogen-bonded linkages between one rod and another shows that it is variable from 5·5 to 7·5 A. In view of this, there must be a periodic distribution of the *R*-type residues. The details are not easy to work out, but an interesting result emerges, namely, that the distribution of *R*-groups along the fibre axis will not have a period of 618 A., but one-sixth of this. It is indeed noteworthy that electron micrographs of collagen stained with phosphotungstic acid exhibit[10] such a six-fold subdivision of the gross period of 640 A.

The agreement of 618 A. with 640 A. observed for dry collagen is not close enough, nor is the six-fold subdivision exact[11]. However, it must be mentioned that it is not at all certain that the unit cell of collagen is hexagonal. It is probably monoclinic even in the dry state with slightly differing *a* and *b* (taking *c* as monoclinic axis), as is found to be the case with wet collagen[12]. The subdivision of 618 A. would then not be exactly into six equal parts, and further the angle φ may be different from 35° and the macro-period may also differ from 618 A. The variation of the long spacing with moisture[9] is to be attributed to the changes in the angle of the monoclinic cell.

Further details of this work are reserved for a separate communication. [June 3

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ECOLOGY OF SNOWDONIA

Ecology of Livestock Productivity

PHILLIPS *et al.*[1–3] have shown how climatic factors have a marked influence on livestock productivity in Wales. In Snowdonia[3], the mean estimated dead-weights of ewes and lambs reaching the livestock collecting centres of the high-rainfall western section (precipitation generally greater than 100 in. mean annual rainfall) are less than those reaching Conway in the drier east (precipitation less than 100 in. mean annual rainfall).

A study[4] of summer grazing intensity over fifty-five sheepwalks (mainly enclosed) in Snowdonia (for the years 1945, 1948, 1949 and 1950) has shown that a significant difference, which can be attributed to rainfall differences, exists between eastern and western sheepwalks in the region. Western Snowdon sheepwalks (twelve in number) bear a mean grazing intensity of 1·27, while the eastern Conway Valley sheepwalks (forty-three in number) bear 1·94 ewe units to the acre[5].

It is, however, evident that factors other than those of climate do affect sheep grazing intensity in Snowdonia. The fifty-five sheepwalks have been classified into nine ecological groups. Some of these ecological groups are differentiated from each other by local climate, and others by soil and vegetational factors. An analysis of variance of the sheep grazing intensity over these sheepwalks shows that the main source of variation is due to ecological factors (variance ratio of 36·09 derived from ecological group and residual variances, based on 8 and 161 degrees of freedom)[4].

Lower rainfall, Eastern Snowdonia (Conway Valley section). Here soil and related vegetation have a major influence on sheep grazing intensity (see also refs. 6, 7). The highest sheep grazing intensity is found where (*a*) precipitation is less than 70–80 in. mean annual rainfall; (*b*) the soil parent material is either a basic Ordovician dolerite or pumice tuff, and the derived soil is akin to a brown earth; (*c*) soil drainage is free; (*d*) the vegetation is basically a *prato-Agrostideto-Festucetum* (an agrostis-fescue grassland in which *Trifolium repens, Dactylis glomerata, Plantago lanceolata, Achillea millefolium, Poa pratensis*, etc., are prevalent), typically distributed between 800 ft. and 1,450 ft. and locally 1,800 ft. O.D. Accruing from these investigations, much is known about the floristic composition of this kind of plant community; it varies much with local rainfall, soil properties (particularly exchangeable calcium) and grazing intensity[4,5].

Eleven such sheepwalks at the lower altitudes have a mean grazing intensity of 2·84 and three at higher altitudes 2·46 ewe units per acre.

Blanket peat areas, as would be expected, bear a much lower sheep grazing intensity (1·36 ewe units to the acre, a mean of five sheepwalks).

Acidic terrains with more podsolic soils derived from rhyolite and bearing a heathy vegetation are not prevalent in the Conway Valley. Only one major sheepwalk of this kind occurs there, and this bears a sheep grazing intensity of 1·70 ewe units per acre. It is difficult to assess the statistical significance of this, but the level of grazing intensity is according to expectation.

Glacial Drift, containing much basic igneous and volcanic materials (dolerites and pumice tuffs) under conditions of free drainage, gives rise to similar soils and vegetation, as do the dolerites and pumice tuffs *in situ*[8]. Impeded drainage abounds, however, and various *Nardus, Molinia, Juncus* and bog communities are prevalent. Such terrains on the average carry 1 ewe unit per acre less than the better kind of basic terrain (one group of eight such sheepwalks carried a mean of 1·70 and another group of thirteen 2·02 ewe units per acre). This contrast in sheep grazing intensity gives a measure of the possible increase in productivity following drainage.

Higher rainfall, Western Snowdonia (Snowdon section). In the Snowdon section it is possible to compare directly a number of sheepwalks on basic (pumice tuff and dolerite) and acidic (rhyolite) terrains. No statistical difference in grazing intensity exists between such terrains (basic terrains, mean of four walks, 1·39; acidic terrains, mean of eight walks, 1·21 ewe units per acre). Under the prevailing high rainfall conditions, the properties of soils derived from different parent rocks tend to merge, though vegetational differences persist[5]. Here, therefore, climatic factors are of paramount importance, and vegetational differences appear to have little influence on sheep grazing intensity.

The general conclusions that emerge from this study are:

(1) For the Snowdonia region as a whole, though environmentally complex, climatic factors, in particular rainfall, are the major influence determining livestock productivity estimated in terms of the number of stock per acre. These conclusions are similar to those of Phillips[3], who has considered productivity in terms of estimated dead-weight.

(2) Within the lower-rainfall Conway Valley area, geological and physiographical complexity affecting soil and vegetation have, however, an important bearing on livestock productivity, so that over a major part of Snowdonia, where precipitation is less than 70–80 in. mean annual rainfall, the basic igneous and volcanic terrains are of first importance to its livestock economy. Locally, even at higher rainfalls, these terrains are important grazing foci.

(3) The arctic–alpine element in the flora of Snowdonia is found mainly on these basic rocks. It is of interest to the problem of the conservation of this flora that it survives locally in the face of considerable grazing pressure. This needs detailed investigation.

(4) Environmental variations in an area like Snowdonia are of an extreme and complex kind. They are available within a single compact region and can provide a fruitful field of inquiry into fundamental ecological problems and also into animal productivity and health in relation to environment[4].

I am indebted to the Agricultural Research Council for financial help, and to Prof. R. Alun Roberts for his encouragement and facilities placed at my disposal. Part of the work outlined here was carried out at the School of Agriculture, Cambridge, and thanks are also due to Sir Frank Engledow for the facilities provided there for part of this investigation. A more detailed account of this work will appear elsewhere. A statistical appraisal of the results has already been given[4].

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Wild White Clover in Natural Mountain Grassland

In the course of ecological investigations from Bangor, it has been found that there is a considerable number of outcrops of soft base-rich rocks distributed throughout Snowdonia which have a marked effect on the natural vegetation. The cliffs and crevices harbour an Arctic–Alpine flora and have been well described. On the slopes, however, there is an extremely different distinctive vegetation, a grassland scarcely distinguishable from lowland base rich grassland, about which little is known[1].

Cwm Llefrith, which is situated between Moel Hebog and Moel yr Ogof in South Caernarvonshire, is being investigated. This is related to a more general study of mountain grasslands by R. E. Hughes, preliminary details of which are given in the preceding communication. The upper reaches of this Cwm carry a very rich pasture in which wild white clover features prominently, though at 1,600–1,800 ft. in a rainfall of 100 in. The soil is a well-drained brown-earth type with a good crumb structure and very little undecayed organic matter, similar to those described in East Snowdonia by Hughes[2], the underlying rock being a magnesium-rich soft volcanic ash.

In pastoral Snowdonia, Cwm Llefrith is outstanding for the record of its productivity (Cwm Llefrith means milky cwm). Summer milk production used to be a prominent feature of its economy to the close of the past century. Every autumn about three tons of salted butter was taken from a single farm and sold at the slate-quarrying district of Blaenau Festiniog for winter use. Now under sheep, its carrying capacity is about two ewes to the acre, a capacity well above that of the surrounding districts. Hughes[1] reports a similar state of affairs elsewhere in Snowdonia. The basis of this remarkable productivity at such a high altitude seems to a great extent to be due to the abundance of wild white clover and the fertility of the accompanying sward.

From preliminary transplant experiments, a distinctive ecological race of wild white clover seems to have been differentiated, characterized by small size but extreme persistence, adapted to upland conditions of grazing and climate. Such a race is capable of enduring successfully the rigour of climatic conditions at high altitudes while lowland races are not. At the same time, it is likely that the mountain race shows some adaptation to low base content and low *p*H, since the soil in Cwm Llefrith, while it approaches that of lowland soil, is by no means identical with it.

The implications of such a situation are far-reaching in the economics of the reclamation and improvement of hill regions at the present state of our national economy, and make investigations on the ecology and genetics of wild white clover paramount in such regions.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Role of Nucleic Acid and Enzymes in Peptide Chain Synthesis

RECENTLY, there has been much discussion of possible mechanisms whereby the order of the nucleotide sequence in a polynucleotide chain might determine the order of the amino-acid sequence in a peptide chain. The polynucleotide molecule is assumed to be the template or pattern for the peptide chain. In a mechanism proposed by one of us[1], enzymes were assumed to play an important part in attaching the amino-acids to the polynucleotide chain; as many enzymes would be required for this purpose as there are nucleotide combinations corresponding to amino-acids. In a system where a nucleotide triad is assumed to correspond to a given amino-acid, there must be as many enzymes as there are triads, and it can be shown that more than one triad would have to correspond to a given amino-acid in order to permit the occurrence of a reasonably large number of possible neighbours on either side of a given amino-acid in a peptide chain (unless it is postulated that there is to be no overlapping of the triads).

Since there are forty possible nucleotide triads, assuming direction along the polynucleotide chain to have no effect, or sixty-four triads if direction is important, there would have to be somewhere between forty and sixty-four specific enzymes to make the scheme in question function. While a synthesizing mechanism such as the one outlined could, once established, in theory produce these enzymes along with all the others for which nucleic acid templates existed, it is hard to understand how the mechanism could develop in evolution without the pre-existence of the forty to sixty-four operating enzymes just mentioned. Therefore it would seem of interest to explore possible mechanisms not involving the use of enzymes to attach the amino-acids to the nucleic acid template.

If enzymes do not attach the amino-acids to the template, the amino-acids apparently must be held by functional groups on the nucleic acid itself. An enzyme may function chiefly because of the exact geometrical relationships among its substrate-binding and catalytic groups, and hence it does not seem entirely unreasonable to assume that nucleic acid might act in a similar manner, especially since it possesses some of the same types of functional groups as are found on protein molecules. Such an idea has already in fact been advocated[2], although without much consideration of detail. The geometry of the ribonucleic acid molecule is not yet sufficiently known for one to decide whether the amino-acids could be bound by the functional groups of the purines and pyrimidines in the proper positions for attachment to phosphate groups, but one point in this connexion does seem fairly clear. This is that nucleotide triads could scarcely be expected to bind or determine the location of a given amino-acid in the absence of enzymes catalysing the process of attachment. This is because too long a segment of the polynucleotide chain is involved. On the other hand, it can be shown that too little information is stored in pairs of nucleotides, or diads, to account for the complexity of arrangement already observed in peptide chains, if one considers such diads in the way that has been customary up to the present time.

There is, however, one possible consideration which seems to have been overlooked, and in theory it could make possible the storage of enough information in nucleotide diads to account for the observed complexities of composition of peptide chains. This is that the rings of adjacent nucleotides (sugar, purine, pyrimidine) may lie close enough together to prevent free rotation about the bond connecting the sugar to the base. In this case a given base might have either one side or the other 'up' but not both, so that a new kind of geometrical isomerism would arise in the polynucleotide chain; this would greatly simplify the problem of information transfer from a polynucleotide to a polypeptide chain. This situation means that we would set up sixty-four different nucleotide diads, if direction along the polynucleotide chain were of importance. For example, we can start with diads containing adenine, with the ring 'up'. ('Up' and 'down' have no real meaning in this sense except to distinguish the two possible positions of the ring.) Let A_u be adenine with ring up, G_u guanine with ring up, C_d cytosine with ring down, etc. The diad pairs are:

A_u—A_u A_u—A_d A_u—G_u A_u—G_d A_u—C_u A_u—C_d A_u—U_u A_u—U_d

It should be noted that this system would not function if the nitrogen of the purine or pyrimidine which is also attached to the sugar were of fixed optical configuration; but such a nitrogen usually does not maintain optical asymmetry. Coiling of the polynucleotide chain should not interfere greatly unless extreme.

With these sixty-four possible diads, it is in theory possible to assign three diad pairs to a given amino-acid and still have four left over. Since each assignment permits of eight possible neighbours for a given amino-acid on one side, the three assignments permit twenty-four possible neighbours, and the 'neighbour problem' disappears.

Such a system might require very few or possibly no enzymes, and would lend itself to attempts to explain the evolutionary development of protein synthesis. The system of assignments of nucleotide diads to given amino-acids might depend almost entirely on molecular geometry, and therefore should be the same throughout Nature as advocated by Dr. G. Gamow and collaborators (personal communication). The assignments should be susceptible of solution by an advanced study of the possible structures for ribonucleic acid. The most difficult aspect of the scheme seems to be to make it select from among the amino-acids glycine, alanine, valine, leucine, *iso*leucine and perhaps phenyl alanine, which do not have functional groups other than one carboxyl and an α-amino group; but any scheme would seem to face this problem. The scheme is very flexible, however, and could account for the change of a single amino-acid in a peptide chain or the transposition of two amino-acids only, whereas a scheme involving nucleotide triads presents difficulties in this respect. It is true that the system would require the presence of a polynucleotide-synthesizing mechanism that could distinguish and reproduce the 'up' and 'down' configurations of the bases, but such a system does not seem impossible to imagine. It should be noted that if the type of isomerism in question should be preserved in oligo-nucleotides produced by the action

of ribonuclease on ribonucleic acid, it might be possible experimentally to find oligo-nucleotides of identical nucleotide sequences but with slightly different physical or chemical properties; although this might be difficult because of the large number of theoretically possible isomers even for a very short polynucleotide.

The senior author is indebted to Drs. G. Gamow, M. Ycas and A. Rich for the free communication of much of their thinking, which has been extremely helpful in bringing him up to date on the problem of the transfer of information.

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Role of Pantothenic Acid in the Reproductive Cycle of Ovaries in Fish

In the course of an investigation of the vitamin contents of different organs of the tunny (*Thunnus thynnus*) caught off the coast of Norway, very high values were found for pantothenic acid in the ovaries, up to 245 μgm. per gm. of fresh tissue[1]. The tunny spawns in the Mediterranean and nearby waters in June and early July, whereupon shoals of the fish move in search for food and arrive off the coast of Norway in July–October. At this time the ovaries are small and in the first stages of a new reproductive cycle. Earlier observations in ovaries (hard roes) from different species of fish had indicated differences in the pantothenic acid content in relation to their degree of 'ripening', the values being lowest at the time of spawning. The findings in the ovaries from the tunny indicated a relation between the pantothenic acid in the ovaries and the sexual cycle of the fish. As cod (*Gadus morrhua*) of all sizes are brought alive to the fish market in Bergen all the year round, it was chosen as a suitable species for the further investigations.

Sivertsen[2] has investigated the spawning of the cod especially with regard to the yearly cycles of the regeneration of the reproductive organs. Based on his findings, ovaries from cod were collected during the period September–April, thus giving samples covering all stages of the development. The pantothenic acid concentrations were determined by the microbiological method using *Lactobacillus arabinosus* as test organism. The results are plotted logarithmically in Fig. 1, which gives the following general picture. In the ovaries of juvenile fish and of mature fish in the first stages of regeneration the pantothenic acid contents were high. Values up to 375 μgm. per gm. of fresh weight, 2,320 μgm. per gm. of dry weight were found, with an average of respectively 250 and 1,650 μgm. These values are in themselves of great interest as the highest reported pantothenic acid content found in natural sources. Pearson and Burgin[3] found that royal jelly, the special food given to those bee larvæ that are destined to become

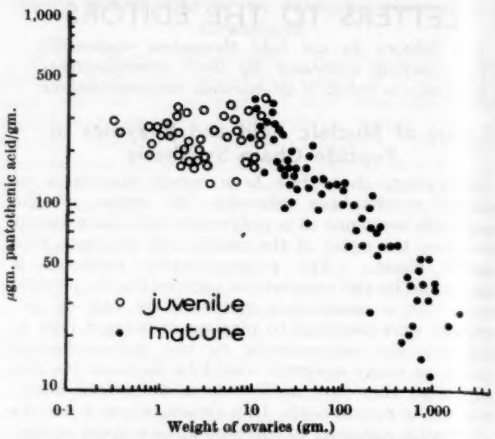

Fig. 1. Relation between pantothenic acid content and size of ovaries in juvenile and mature cod (*Gadus morrhua*)

queens, contained an average of 183 μgm. pantothenic acid per gm. of fresh weight or 511 μgm. per gm. of dry weight. These values were the highest reported in Nature up to the present investigation. During the regenerative or reproductive growth of the ovaries in mature fish, the pantothenic acid content decreases, and finally it reaches values of approximately 10–30 μgm. per gm. of fresh weight shortly before spawning. In the very last stage of the reproductive cycle the ovaries take up considerable amounts of water, and after spawning the eggs contain only 5–10 μgm. pantothenic acid per gm. of fresh weight. The findings indicate that pantothenic acid may play an important part in the metamorphosis of the ovaries in fish.

Investigation of the contents of other factors of the vitamin B complex are in progress. Riboflavin and niacin did not show similar changes, while vitamin B_{12} showed values decreasing from an average of 0·25 to 0·11 μgm. per gm. of fresh weight. Thus, of the factors so far investigated, only pantothenic acid shows the unique relation to the reproductive cycle reported above. The total dry matter of the ovaries increased from approximately 15 to 20 or 25 per cent during the growth of the ovaries; thus simple dilution effects are excluded. The results will be published in detail elsewhere.

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A Technique for studying the *in vitro* Effect of Serum on Activated Taeniid Hexacanth Embryos

The *in vitro* effects of normal and immune serum on various nematode larvæ and on schistosome cercariæ have been described by a number of workers[1]. The use of helminth larvæ for the detection of natural and acquired immune responses has proved to be a very useful immunological tool, and some progress has been made towards using this

method in the diagnosis of some nematode and blood-fluke infections.

The problem of applying this technique to the study of the host–parasite relations in cestode helminth infections is complicated by several factors. The penetrating larvæ of cestodes, the hexacanth embryos, particularly those belonging to the family Taeniidae, are contained within the several membranes of the tapeworm egg and are not readily available in a free and active state. The process of hatching and activating mature taeniid hexacanth embryos may be brought about under certain conditions by the use of appropriate enzymes and bile constituents[2]. The success of the hatching technique depends upon the selection of mature tapeworm eggs. It has been shown that naturally expelled tapeworm ova vary in their state of maturity[3], and for this reason, freshly obtained taeniid tapeworm eggs are stored in normal saline until hatching tests reveal that at least 30 per cent of the ova may be activated.

Only one previous worker has reported attempts to study the effects of sera on the penetrating larvæ of a cestode helminth. Chen[4], working with *Taenia taeniaeformis*, was not able to demonstrate any effect of rat immune serum on the hexacanth embryos. It appears from the description of his hatching technique that although he had obtained disintegration of the embryophores, the embryos contained within the oncospheral membrane had not been stimulated to activity and in consequence had not freed themselves from the oncospheral membrane. We have been studying the effects of calf and rabbit sera on the hexacanth embryos of *Taenia saginata* and *T. pisiformis* which have freed themselves from their membranes after activation, and have observed several types of serum reactions.

Our technique of hatching and activating the embryos has been previously described[2]. All operations are carried out in centrifuge tubes which are kept in a water-bath (38°–40° C.). Precautions are taken throughout to minimize the introduction of bacteria. After 30 min. treatment in the final activating solution, the embryos are sedimented by gentle centrifugation (1,500 r.p.m. for 1 min., centrifuge radius 5½ in.), and the supernatant solution replaced with warmed (38° C.) normal saline. The embryos are rinsed in saline, sedimented and the saline replaced with 0·1–0·5 c.c. of the test serum. The serum and activated embryos are allowed to stand in the water-bath for 1 hr. before observations are made. Some reactions have been noted after only 15 min. Observation counts have been made at 1-, 2-, 3-, 4-, 5- and 6-hr. intervals as well as after overnight standing. Positive reactions are usually visible by one hour. Warmed ringed slides are used with a microscope stage warmer designed to keep the slide temperature at between 38° and 40° C. Only those embryos which have been successfully activated are counted in the observations.

Free activated hexacanth embryos may show several types of reactions. (1) Precipitates may form around the secretions of the penetrating gland and at other points on the embryos (Figs. 1 and 2). (2) A membrane may form enclosing the entire embryo and its secretions. (3) A lethal and lytic effect has been noted in inactivated immune sera and in some active and inactivated normal sera, particularly at the 3-hr. and later readings.

Oncospheral membranes that contain activated embryos which have not succeeded in freeing themselves may show a thickening precipitate on the inner surface of the membrane. This may be a result of the serum reaction to the embryo's secretions, and would appear to indicate that the serum-precipitating factor can pass through the semipermeable oncospheral membrane.

Fig. 1. A free and active taeniid hexacanth embryo in non-reacting serum which demonstrates the normal appearance of the gland secretions (*gs*) and hooks (*h*)

Fig. 2. A free and active taeniid hexacanth embryo in a reacting serum which demonstrates the thick precipitate reaction to the gland secretion (*gsp*) and the precipitates which form at the base of the hooks (*hp*)

Inactive oncospheres show a tendency to clump. This clumping occurs in all sera, however, and no other visible effects have been observed.

It is of interest to note the remarkable effect of serum in sustaining hexacanth embryos in an active state. Embryos may remain in a state of constant activity in sera for three hours or more, whereas in other solutions, such as intestinal juice or normal saline, activity usually ceases within one hour. Embryos kept on the bench overnight in normal inactivated serum may be reheated and reactivated again on the following day.

Studies are in progress using the technique described above to follow the development of immune responses in animals at various ages and at different stages of infection.

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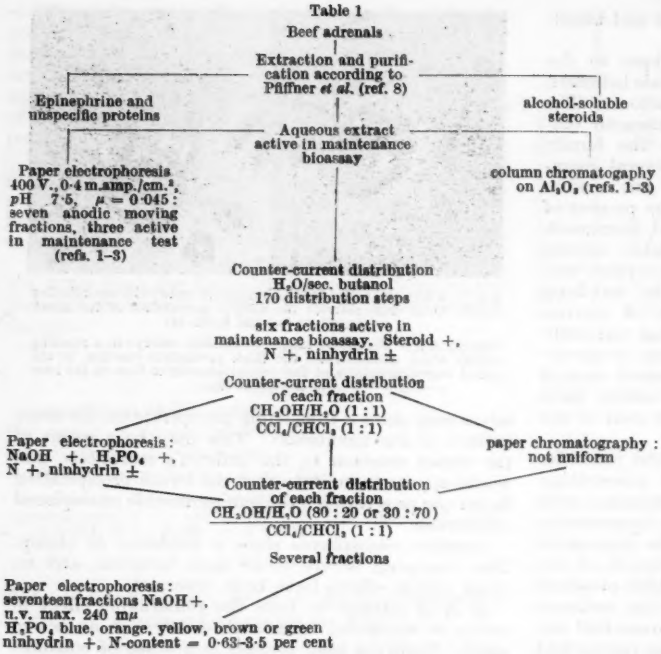
Nitrogen-containing Steroids in Aqueous Adrenal Cortical Extracts

PREVIOUS investigations on the nature of aqueous adrenal cortical extracts led to the isolation of potent fractions as assessed in the golden hamster maintenance test. A preliminary analysis of the crude fractions suggested the presence of nitrogen[1–3], and on further separation the potent mixtures yielded substances which according to our criteria possessed steroidal properties besides containing nitrogen. The course of the separation is outlined in Table 1.

A number of these substances could be isolated by combining various fractionation procedures such as counter-current distribution, paper electrophoresis, and paper chromatography. 13·0–36·5 per cent of the material gave a positive Zimmermann reaction in an early separation step; 18·4–43·9 per cent

Table 1


Beef adrenals
Extraction and purification according to Pfiffner et al. (ref. 8)
Epinephrine and unspecific proteins
alcohol-soluble steroids
Aqueous extract active in maintenance bioassay
Paper electrophoresis 400 V., 0·4 m.amp./cm.², pH 7·5, μ = 0·045 : seven anodic moving fractions, three active in maintenance test (refs. 1–3)
column chromatography on Al₂O₃ (refs. 1–3)
Counter-current distribution H₂O/sec. butanol 170 distribution steps
six fractions active in maintenance bioassay. Steroid +, N +, ninhydrin ±
Counter-current distribution of each fraction CH₃OH/H₂O (1 : 1) / CCl₄/CHCl₃ (1 : 1)
Paper electrophoresis : NaOH +, H₃PO₄ +, N +, ninhydrin ±
paper chromatography : not uniform
Counter-current distribution of each fraction CH₃OH/H₂O (80 : 20 or 30 : 70) / CCl₄/CHCl₃ (1 : 1)
Several fractions
Paper electrophoresis : seventeen fractions NaOH +, u.v. max. 240 mμ H₃PO₄ blue, orange, yellow, brown or green ninhydrin +, N-content = 0·63–3·5 per cent

reacted as total neutral reducing lipids (Heard and Sobel). The nitrogen content varied between 0·8 and 4·5 per cent. The biuret and sometimes the ninhydrin reactions were negative, in contrast to the final fractions, which reacted strongly with ninhydrin. After electrophoretic separation most of the ninhydrin-positive bands also exhibited fluorescence with sodium hydroxide and phosphoric acid. Only a small number of ninhydrin-positive bands moved to the cathode; the rest, moving to the anode, did not always correspond to the steroid bands usually found here under our experimental conditions. Some of these bands were ninhydrin-negative.

A more detailed description will be given of six fractions which, out of a total of seventeen ninhydrin-positive fractions, have been assayed in the golden hamster maintenance test. All these fractions fluoresced with sodium hydroxide and phosphoric acid. Their nitrogen-content ranged from 0·63 to 3·5 per cent; in four of them it amounted to 2·59 – 3·50 per cent. If the mean molecular weight of the steroid component is taken as 300, this would agree with the theoretically calculated amount assuming that nitrogen is bound to the steroid nucleus in the form of an amino-acid or at most of an oligopeptide. According to the positive ninhydrin reaction and the anodic movement of the compounds, the carboxyl group as well as the α-amino-group should be present in a free state. Ultra-violet spectrophotometric analysis of the steroidal component showed an absorption maximum at about 240 mμ. This, together with the sodium hydroxide fluorescence, strongly indicates the presence of a Δ^4-3-keto configuration. The fluorescing colours produced with phosphoric acid were equal to those shown by the biologically active corticosteroids[4].

Taking this evidence into account, it can be assumed that these substances are α,β-unsaturated 3-keto corticoids possessing an exocyclic additional amino-acid component. The presence of similar compounds in urine was recently reported by Eades *et al.*[5], and by Hudson and Lombardo[6]. The latter also suggested their presence in adrenal cortical extracts and adrenal vein blood. Nothing definite can as yet be said on the nature of the binding, though there is a possibility that a mechanism is involved comparable to the binding of steroids to protein as discussed by Areshkina *et al.*[7].

The large number of fractions isolated may be explained by supposing that these consist of different steroids and/or amino-acid components, though there is no doubt that in part the methods applied are involved, as the counter-current distribution in particular tends to show overlapping in closely adjacent fractions.

Whereas the total extract shows a strong activity in the life-maintaining assay, which is still present in the early fractions, no such activity was detectable with certainty in the six purified bands examined. It should be understood that by this bioassay only one property of certain steroids can be demonstrated, therefore no conclusions can be drawn from this test on the biological significance of our substances. Investigations are in progress to find out whether these substances represent a special hormone group or merely a transport form, or whether they are intermediates in the biosynthesis of corticosteroids.

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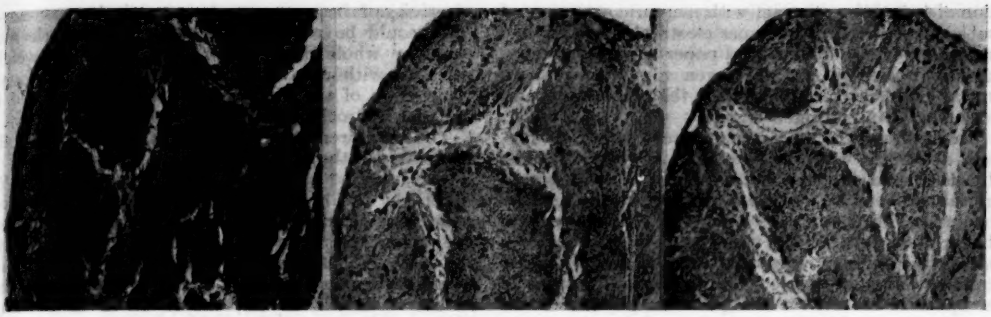
Selective Digestion of the Neurosecretory Material of the Hypothalamus and of the Neurohypophysis by Tissue Homogenates

Various authors[1,2] claim, mostly on indirect evidence, that the neurosecretory colloid material present in histological preparations of the hypothalamus and in the neurohypophysis is related to the hormones of the posterior lobe of the hypophysis, probably to the antidiuretic hormone. However, Hild and Zetler[3] reported that some solvents extract the neurosecretory colloid material without modifying the antidiuretic activity.



(a) (b) (c)

Fig. 1. Neurohypophysis of *Bufo icterieus*; Gomori's chromallum hæmatoxylin stain (× 150): (*a*) incubated with distilled water; (*b*) incubated with liver homogenate, not heated; (*c*) incubated with liver homogenate, heated at 80° C. for 10 min.

Since various tissue homogenates were found to inactivate the antidiuretic action of posterior pituitary extracts[4,5], it appeared interesting to try the action of such homogenates on the neurosecretory colloid material.

We investigated the action of homogenates of various rat tissues—liver, spleen, lung, kidney, striated muscle—on histological sections of the hypothalamus and the hypophysis from dog, cat and from several species of *Bufo* (*B. arenarum*, *B. marinus*, *B. ictericus*).

One volume of the organ was homogenized with four volumes of distilled water in a Waring blender, and the solution centrifuged for 10 min. at 1,800 *g*. The *p*H of the supernatant was adjusted to *p*H 6·0–7·0 with *N*/4 sodium hydroxide and the solution was used either immediately or after heating for 10–15 min. at 80° C. or at 98° C.

The hypothalami and hypophysis were fixed for twenty-four hours in a saturated mercuric chloride solution containing 10 per cent formalin, embedded in paraffin and cut at 8μ. After removal of the paraffin, the sections were incubated with the homogenates for 4–5 hr. at 37° C. Control preparations were incubated in distilled water. After the incubation, both the control and the treated preparations were rinsed in running tap water for 5–10 min. and stained by one of the following techniques, which are known to stain the neurosecretory material: (*a*) chromic hæmatoxylin–phloxin method[6]; (*b*) Gomori paraldehyde–fuchsin as modified by Gastaldi[7]; (*c*) periodic–Schiff reaction[8].

In these conditions, we found that the colloid material cannot be demonstrated in the sections treated by the homogenates, although it remains unaltered in the control preparations.

According to Birnie[5], the homogenates which destroy the antidiuretic activity of posterior hypophysis extracts contain an enzymatic system that is inactivated by heating at 80° C. for 10 min. However, the homogenates heated at 80° C. and at 98° C. for 10 min. have the same action on the neurosecretory colloid material as untreated ones. Thus the action on the neurosecretory material appears to be different from the antidiuretic hormone-inactivating system previously described by Birnie.

Attempts to purify and to identify the active substance are in progress.

We tried the action of the homogenates on various organs of the rat (kidney, pancreas, intestine, stomach, adrenal, salivary glands, testicle, thymus) in the same conditions as those of the previous experiments. We found that no other histological element that stains by the Gomori methods is altered by this treatment. An exception is the beta cell granules of the islets of Langerhans of the pancreas, which can no longer be stained after this treatment. The significance of this finding will be studied elsewhere.

Thus the action of the homogenates on the Gomori-positive neurosecretory material appears to be specific. It is hoped that these properties may be used in order to provide a histochemical method to identify this substance.

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Glutamine as an Accelerator of Chondroitin Sulphate Synthesis

The sulphate exchange of chondroitin sulphuric acid can easily be studied *in vitro* in surviving slices of cartilage suspended in a Krebs–Ringer-bicarbonate solution containing ^{35}S-labelled sulphate[1,2]. The influence of various factors on this reaction, which is of an enzymatic nature, has been studied in this department. In the course of the work, it was noted that small amounts of a liver homogenate added to the suspending medium produced a remarkable stimulation of the sulphate incorporation into chondroitin sulphuric acid. As reported in a preliminary paper[3], this effect was found to be due to the presence in the liver of a thermostable, dialysable factor.

In a subsequent study[3], it was found that this 'sulphate-exchange stimulating factor' is present not only in the liver, but also in several other organs and tissues, for example, brain, muscles and lung. It is also present in the serum of various animals. The sulphate-exchange stimulating factor from calf liver could be purified by means of fractional precipita-

tion of boiled liver extract with mercuric acetate, and subsequent preparative paper electrophoresis. When subjected to two-dimensional paper chromatography, the final product showed seven ninhydrin-positive spots, one of which contained the whole sulphate-exchange stimulating activity.

In the course of the aforementioned investigation[2], our attention was directed to a recent paper by Lowther and Rogers[4] concerning the influence of glutamine on the synthesis of hyaluronic acid by bacteria. In it they also referred to the work of Leloir and Cardini[5] on the action of glutamine in the biosynthesis of glucosamine by *Neurospora crassa*. When we added glutamine to the series of compounds studied in the previous paper[2], it was found to have a five times greater sulphate-exchange stimulating activity per mgm. of dry substance than that of the electrophoretically purified sulphate-exchange stimulating factor from calf liver.

The evidence supporting the conclusion that the sulphate-exchange stimulating factor is probably identical with glutamine is as follows:

1. The sulphate-exchange stimulating-active ninhydrin-positive spot and L-glutamine have the same R_F value in the solvents used for two-dimensional paper chromatography (80 per cent ethanol in water; *sec*-butanol–90 per cent formic acid–water: 75+15+10 parts, respectively).

2. In chromatography on the cation exchange resin 'Dowex 50', L-glutamine and the sulphate-exchange stimulating factor have the same effluent volume when tested separately as well as in mixed chromatography. The recovery of glutamine is not quantitative[6]; this also applies to the sulphate-exchange stimulating factor.

On the basis of the observations reported above, it seems likely that glutamine plays a part in the biosynthesis of mammalian mucopolysaccharides.

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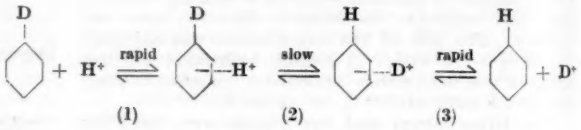
Hydrogen Isotope Exchange between Aromatic Molecules and Aqueous Acids

The hydrogen isotope exchange between an aromatic compound and aqueous acid without the intervention of heterogeneous catalysts can be regarded as an electrophilic aromatic substitution reaction[1]. It is also known qualitatively that the kinetic efficiency of the acid increases with its strength[2]. We have now examined quantitatively the nature of this dependence upon acidity in homogeneous solution at 25° and have drawn some more specific conclusions about the mechanism of the reaction.

The compounds investigated were *ortho*-deutero derivatives of *p*-cresol, *p*-chlorophenol and *p*-nitrophenol, and monodeuterobenzene. The difference in reactivity of these compounds was such that exchange rates could be measured in aqueous sulphuric acid over the whole composition range 9·2–97·6 weight per cent without a disturbing amount of sulphonation. Two of the compounds were also studied in aqueous hydrochloric and phosphoric acids.

The measurements indicate that, for each of the compounds, the logarithm of the rate-constant is linearly related to Hammett's acidity function[3] H_0, except at the highest acidities (higher than 85 per cent) where the increase of rate is less steep. There are minor discrepancies between the slopes of the log k vs. H_0 lines and the ideal slope of -1, but these discrepancies are no greater than those found in the cases of other reactions which are held to satisfy this relation and they can be interpreted qualitatively[4]. We have also attempted to correlate the reaction velocities with the concentrations of the different proton donors present in concentrated aqueous acids, using results derived from the intensities of Raman spectra[5], but this alternative analysis of the data was unsatisfactory.

If we accept the usual interpretation of a linear relation between the logarithm of a rate-constant and H_0, our results point to the existence of a rapidly attained pre-equilibrium in which the aromatic molecule accepts a proton to form a conjugate acid in which the entering atom and the isotopic atom being replaced occupy non-equivalent positions. The rate-controlling step is then a rearrangement of this molecule, without intervention of the solvent:



By analogy with the case of aromatic nitration[6], it seems likely that step (2) proceeds via an intermediate in which deuterium and hydrogen occupy equivalent positions, that is,

Since the dependence of the reaction velocity on acidity is the same for benzene as for the substituted phenols, the proton attachment in the intermediate is probably of a non-classical kind, which we like to describe as 'outer complex'[7] formation. This outer complex may involve the same kind of bonding as has been suggested for certain of the so-called 'π-complexes'[8]. Its structure is likely to be analogous to that of the non-classical intermediate which has been postulated for the acid-catalysed hydration of *iso*butylene[9].

It must be left undecided for the present whether the reaction scheme put forward for the hydrogen isotope exchange will find a necessary place in the general theory of electrophilic substitution reactions or whether its applicability is to remain confined to substitution by protons.

A fuller presentation of the results and of the arguments leading to the conclusions outlined in this

communication is being submitted for publication elsewhere.

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Mechanism of the Reduction of Tetrazolium Salts

Investigations undertaken since our previous publication[1] seem to permit of the following additional statements on the reduction and photochemical properties, respectively, of tetrazolium salts used as dehydrogenase indicators.

Alkalinity of the medium accelerates not only the disproportionation and chemical reduction of triphenyltetrazolium chloride, but also the oxidation of formazane. In a strongly alkaline medium all three reactions occur also in the absence of light, the presence of which is known to catalyse them considerably[1–9]. Heat and the presence of certain colloids, for example, gelatine, also increase the rate of these reactions. It was in the disproportionation and chemical reduction of triphenyltetrazolium chloride that the accelerating effect of gelatine could be observed.

Under the appropriate experimental conditions, the chemical reduction of triphenyltetrazolium chloride to formazane, for example, by the action of ascorbic acid, takes place in a strongly acid medium as well.

The common explanation suggests itself for all these phenomena that the acceleration of these reactions is based on diminishing the activation energy and increasing the reversibility. The effect of gelatine, slightly reminiscent of that of the enzymes, can be explained as follows: a significant part of the activation energy required is furnished by the energy liberated on the adsorption on the gelatine particles of formazane, one product of the reaction. Measured polarographically, its value was about 10 kcal. The reversibility-increasing action of heat and alkalinity could also be shown polarographically. At 20° C., the triphenyltetrazolium chloride ⇌ formazane system was only found to be quite reversible above pH = 14. At lower pH values the irreversibility (the difference between the oxidation and reduction potentials) increased.

Polarographic study of 'photo-triphenyltetrazolium chloride', the final product formed by disproportionation of triphenyltetrazolium chloride on the action of light, has shown: (1) that its polarographic reduction occurs by four electrons, analogous to that of triphenyltetrazolium chloride, but at a more negative reduction potential; (2) that the diffusivity of 'photo-triphenyltetrazolium chloride' is twice that of triphenyltetrazolium chloride in spite of their almost identical molecular weight; the phenyl groups attached to the nitrogen atoms 2 and 3 are forced in the 'photo-triphenyltetrazolium chloride' into a plane; (3) that the polarographic reduction of 'photo-triphenyltetrazolium chloride' results not in the free radical which Kuhn and Jerchel[7] obtained by chemical reduction, but primarily a labile 9-atomic heterocycle is formed, and this is transformed by a secondary reaction into the free radical.

The photo-oxidation of formazane is catalysed not only by its final product (autocatalysis), but also by other fluorescent compounds, showing that autocatalysis is based upon fluorescence. The oxidation of formazane in darkness in alkaline medium is likewise autocatalytic in character; but the catalysis is of a quite different nature: in alkaline medium the 'photo-triphenyltetrazolium chloride' formed as the final product is quickly dismembered with the uptake of hydrogen. The latter is furnished by the as yet unchanged formazane, while this is being oxidized.

In an alkaline medium, disproportionation of triphenyltetrazolium chloride yields in addition to 'photo-triphenyltetrazolium chloride' chiefly formazane, and in an acid medium mainly the colourless 1,2-dihydro-triphenyltetrazolium chloride, exactly the same as in the polarographic reduction of triphenyltetrazolium chloride[10]. In addition, we have studied the behaviour of two ditetrazolium compounds, that of blue tetrazolium and neo-tetrazolium, and found the following:

(1) Their polarographic reduction was analogous to that of triphenyltetrazolium chloride, but many more anomalies could be observed than with the latter.

(2) Light had no catalytic effect on their chemical and enzymatic reduction and disproportionation. Strong alkalinity resulted in their disproportionation; gelatine accelerated their chemical reduction.

(3) Alkalized very carefully in the presence of ascorbic acid, an alcoholic solution of blue tetrazolium becomes red, as a small portion of blue tetrazolium transforms into its red monoformazane readily soluble in water, alcohol or benzene. Under the action of light, benzene solution turns yellow, obviously in connexion with a *cis-trans* transformation[2]; in darkness it turns red again. The diformazane of blue tetrazolium, on the other hand, turns in the light from blue to red, likewise reversibly.

(4) Triphenyltetrazolium chloride, ditetrazolium-salts and 'photo-triphenyltetrazolium chloride' exhibit catalytic polarographic waves.

The details of our results will be published elsewhere[11].

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Separation within the Homologous Series of *n*-Alkyl Sulphates, *n*-Alkyl Pyridium and *n*-Alkyl Trimethyl Ammonium Halides by Paper Chromatography

Methods have been described for the identification of synthetic detergents in admixture with three or four dyestuffs utilizing an ascending chromatogram[1,2]; but these procedures do not allow the separation of mixtures of detergents, neither do they permit the separation of members of a homologous series.

Work carried out in these laboratories has clearly shown that it is possible to effect a complete separation of the normal saturated alkyl sulphates when the adjacent members differ in chain length by two carbon atoms. Mixtures of *n*-octyl, *n*-decyl and *n*-dodecyl sulphates have been separated by ascending paper chromatography using 15 per cent aqueous ethyl alcohol, while 40 per cent aqueous ethyl alcohol has been found effective in separating mixtures of *n*-tetradecyl, *n*-hexadecyl and *n*-octadecyl sulphates. The chromatograms were run at 30° C. using Whatman No. 1 paper.

The position of the spots of the anionic material can be shown by spraying with an aqueous solution of pinacryptol yellow after drying in a current of warm air. When the sprayed chromatogram is examined under ultra-violet light the spots of anionic material fluoresce a bright orange on a pale yellow background. The minimum amount of material capable of detection by this means is of the order of one microgram. Preliminary tests have indicated that this method of separation is applicable to other classes of sulphated and sulphonated detergents.

A parallel investigation of cationic materials has indicated that paper chromatography is capable of effecting the separation of the homologous series of *n*-alkyl pyridinium halides and also the *n*-alkyl trimethyl ammonium halides. The ascending chromatogram of these materials is carried out at 30° C. using 30 per cent aqueous ethyl alcohol containing 5 per cent of concentrated hydrochloric acid. The position of the spots of cationic material is shown by spraying the air-dried chromatogram with an aqueous solution of rhodamine *BS* containing a commercially available optical bleach. The sprayed chromatogram is then exposed to ammonia vapour to neutralize any mineral acid present and examined under the ultra-violet lamp. The spots of the cationic material are seen to fluoresce a bright vermilion on a white background. The method is sensitive to approximately one microgram of cationic material.

It will be appreciated that these methods allow the differentiation of other classes of organic compounds which by means of chemical reaction may be converted to surface-active compounds of the above-mentioned types.

Further investigations on the qualitative and quantitative aspects of the paper chromatography of other classes of anionic and cationic compounds continue, and the results will be published elsewhere at a later date.

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Reproduction of Mumps Virus in the Chorio-allantoic Membrane

Little is known about the reproduction cycle of mumps virus. This seems strange, as some of the techniques available for influenza virus should be applicable to this virus, which is in many ways similar in its reactions. The method introduced by Hoyle[1,2] in his study on the multiplication of influenza virus in egg membranes, however, did not yield clear-cut results with mumps virus. The main difficulties were the slow adsorption of the virus to the reproductive cells, the relatively high proportion of free (vital) virus particles not taking part in the reproduction process during the experiments and the relatively low reproduction velocity. This last factor made it necessary to expand the experiments to more than thirty hours, and consequently the experiments had to be divided into many parts. The comparability of the infection-, hæmagglutination- and other titres is impeded by this division of the experiment.

In five series of experiments eggs were inoculated with 0·1 ml. of a dilution of freshly harvested allantoic fluid of the mumps strain 'Enders'. To measure the infection titre of the inoculum a series of tenfold dilutions was made and three eggs were injected with 0·1 ml. of each dilution. Every half-hour after the infection the allantoic fluids of four eggs were tested for hæmagglutination power, and the chorio-allantoic membranes were harvested. These membranes were ground with quartz sand and brought into suspension with saline (containing penicillin and streptomycin). A series of tenfold dilutions was made and with each dilution three eggs were inoculated. With the same material the amount of complement-fixing antigen was measured. As the whole series of experiments could not be carried out at the same time the series was cut into parts of four hours each. With each part a reference test was carried out half an hour after the inoculation of the eggs.

The following results were obtained (Fig. 1).

Complement-fixing antigen could not be detected before 18½ hr. from inoculation.

Hæmagglutinin did not appear before 19½ hr. from the beginning of the experiment.

Infective material remains detectable throughout the experiment. The infection titre decreases from 2½ hr. after inoculation until it reaches a minimum after 5 hr., to remain low until 14½ hr. after injection. From then onward infection titres increase very slowly. No secondary phase of decrease of infection titres can be detected within 30 hr. The absence of complement-fixing antigen between 21½ hr. and 28 hr. after the beginning of the experiment may be due to technical error. Hæmagglutinin titres show a steady increase not followed by a secondary decrease.

In consecutive experiments the above-mentioned results could not always be repeated. In the case when the initial infection dosage was low no hæmagglutinin or complement-fixing antigen could be detected. In the case when the initial infection dosage was high (10^6 or more), no decrease in infection titre was detectable and the gain in infectivity-rate was relatively low.

In order to get more clear-cut results, we used another experimental arrangement. Chorio-allantoic membranes of nine days old chick embryos were cut into a great number of pieces each of about 0·01 sq. in. After washing in saline, the pieces were put into a Petri dish containing a mumps virus suspension in saline (infection titre 10^{-3}–10^{-4}). After twenty

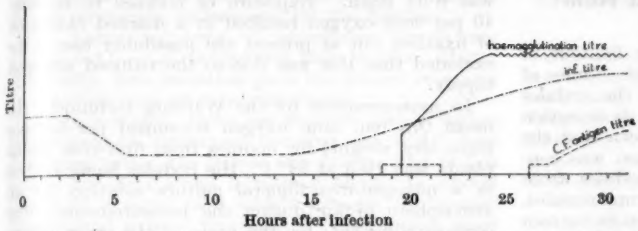

Fig. 1. Multiplication of mumps virus in the chorio-allantoic membrane of incubated hen's eggs

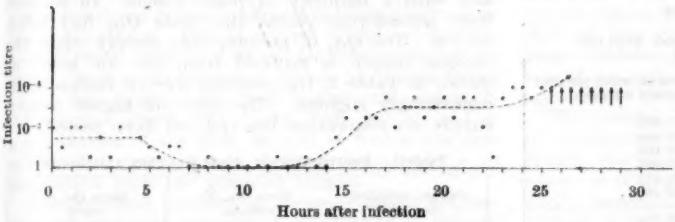

Fig. 2. Virus culture in surviving chorio-allantoic tissues; typical experiment

minutes the pieces were rinsed one by one in several Petri dishes containing saline and then put into roller tubes each containing 1 ml. Tyrode suspension with 400 units penicillin, 0·25 mgm. (0·04 grain) streptomycin, embryo extract and fowl serum. They were then incubated at 37° C. Each half-hour the pieces of membrane from three tubes were ground in a mortar and a suspension was made by adding 0·5 ml. saline (+ penicillin and streptomycin). Tenfold serial dilutions were made and eggs were injected with it and incubated for four days. The results of a typical experiment are demonstrated in Fig. 2.

Mumps virus, we may conclude from these experiments, is reproduced in the living chorio-allantoic cell in about 14–17 hr. The gain in infection titre after such a period is about thirty times the initial amount of virus.

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Trichomonas hominis cultured without Bacteria

Trichomonas hominis, like most other intestinal parasites[1], is usually cultured *in vitro* in a Dobell–Laidlaw biphasic medium (horse serum, rice starch and Ringer's solution to which is added 15 per cent liquid horse serum)[2]. Growth of *T. hominis* in that medium occurs only when associated with bacteria. At 25° C. the equilibrium between bacteria and protozoa is optimum, and after forty days of incubation, *Trichomonas* are still numerous and lively. In such conditions, the maximum protozoal concentration attained is about 200,000 cells/c.c.

For the maintenance of the strain, this association is indeed advantageous; in the same way, Sorel[3] pointed out that *Trichomonas vaginalis* lives longer when associated with fungi of the genus *Candida* than in pure culture. Hitherto, attempts to grow *T. hominis* without bacteria have been unsuccessful. Recently, McEntegart[4], who was working with pure strains of *Trichomonas vaginalis*, *T. foetus* and *T. gallinarum*, confirmed in one of his papers that *T. hominis* cannot grow without bacteria.

These characteristics suggested to other investigators that the parasite might be cultured by techniques used for the growth of *Endamoeba histolytica* without development of bacteria. *T. hominis* was cultured by Shaffer and Biegeleisen[5] in a medium 'preconditioned' by the growth of an anaerobic Gram-negative streptobacillus, removed afterwards by centrifugation. In fact, the behaviour of *T. hominis* and *E. histolytica* is not substantially the same, and growth of the flagellate depends on bacterial growth only when it is cultured in a medium of the Dobell–Laidlaw type.

Working with a strain of *T. hominis* (T.H. strain), kindly sent to me by Prof. L. Lamy from the Institut Pasteur of Paris, I was able to separate *T. hominis* from bacteria by changing the culture medium. At 37° C. in complete media, like *CPLM*[6], or in the media used by McEntegart[7] and Feinberg[8], associated bacteria grow abundantly and destroy *T. hominis* in 24 hr., as was pointed out by Williams *et al.*[9] for *T. foetus*. However, addition of 1,000 μgm./c.c. of streptomycin and 1,000 u./c.c. of penicillin allows the growth of *T. hominis* in these media. After three serial transfers in *CPLM* medium to which these antibiotics have been added, sterility tests in bacto-thioglycolate medium show that *T. hominis* is free from bacteria. The pure strain has been maintained by us for four months, with three-week serial transfers. In these conditions, *T. hominis*, like *T. vaginalis*, attains a concentration higher than two million protozoa per c.c.

The parasite cannot grow further without bacteria in Dobell–Laidlaw medium, even if cysteine or ascorbic acid has been added to it, in order to allow the growth of anaerobic micro-organisms. On the contrary, it grows well if it is re-associated with the original bacteria, or with pure strains of bacteria, like *Streptococcus faecalis* A.T.C.C. 6057, and *Escherichia coli* 120 of our collection.

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Nitrogen Fixation in Detached Non-legume Root Nodules

Previous work has shown that the fixation of nitrogen normally characterizing the root nodules of *Alnus*[1,2] continues after detachment of the nodules from the plant to an extent sufficient for its detection by isotopic technique[3,4]. Bond[4] has shown that the fixation per unit of total nodule nitrogen was considerably greater in such detached nodules from young *Alnus* plants than in detached legume nodules.

Another non-legume possessing nitrogen-fixing root nodules is *Myrica gale*[1,4,5], and the results of isotopic tests with detached nodules of this species are given in Table 1. They show that here also fixation continues to a readily detectable extent.

Table 1. Fixation in Detached *Myrica* Nodules

	Sample No.	Nitrogen-15 content, atom per cent of total nodule nitrogen
Exposed to excess nitrogen-15	1	0·426
	2	0·468
	3	0·468
	4	0·403
	5	0·433
	6	0·463
Controls, exposed to air	7	0·380
	8	0·379

Samples (0·5 gm.) of nodules from water-culture plants were placed in specimen tubes (14 ml.) and these then charged at 1 atmosphere with a mixture containing 20 per cent oxygen and 80 per cent nitrogen (with 18 atom per cent nitrogen-15). The nodules were held at 21° C. for 24 hr. and then assayed for fixed nitrogen-15 in the usual way (ref. 6).

In further studies of detached *Alnus* nodules the effect of oxygen supply on fixation and also some features of respiration have been examined. The results in Table 2 show that the fixation (which is proportional to the increase in nitrogen-15 content) is markedly sensitive to oxygen supply. Analysis of variance confirms that the over-all oxygen effect is highly significant, although the differences between means do not all attain the magnitude required for significance (0·043 atom per cent, $P = 0·05$). For various reasons, one of which is the rapidity of nodular respiration (see below), it is difficult to avoid a substantial fall in oxygen supply during such an experiment, so that over the experimental period as a whole the range of mean oxygen supply was considerably smaller than that provided initially.

Fig. 2. Effect of Oxygen on Fixation in *Alnus* Nodules

	Oxygen initially supplied (per cent)			
	21	12	5	1
Mean increase in nitrogen-15 content, atom per cent of total nodule nitrogen	0·141	0·083	0·054	0·022

Four samples (0·6 gm.) of nodules from young water-culture plants were set up at each oxygen-level in specimen tubes afterwards charged at 1 atmosphere with oxygen/nitrogen mixtures containing 20 atom per cent nitrogen-15. Further treatment was as for *Myrica* nodules. The data show increases over the normal figure of 0·372 atom per cent.

The mass spectrometric analyses on which Table 2 is based were carried out on the whole of the nodule nitrogen; the inability of Virtanen *et al.*[3] to detect fixation satisfactorily in detached *Alnus* nodules except by analysis of the soluble fraction only was probably due to their use of nodules from older plants. Calculation shows that in the present experiment the total fixation (nitrogen-14 and nitrogen-15) per sample exposed initially to 20 per cent oxygen was 0·03 mgm. Exposure of nodules to initially 40 per cent oxygen resulted in a marked reduction of fixation, but at present the possibility cannot be excluded that this was due to the reduced nitrogen supply.

In measurements by the Warburg technique, the mean Q_{O_2} (cu. mm. oxygen consumed per hr. per mgm. dry weight) for nodules from first-year *Alnus* plants was 10·5 at 24° C., the nodules being bathed in a nitrogen-free mineral culture solution in an atmosphere of air during the measurements; the corresponding Q_{O_2} for the roots of the same plants was 3·5. Thus such nodules show rapid respiration, both in comparison with the roots that bore them and with a majority of plant tissues. In nodules from second-year plants the mean Q_{O_2} had fallen to 2·0. The Q_{O_2} of nodules falls steeply when the oxygen supply is reduced from the air level, as shown in Table 3, the response in root tissues being considerably slighter. The effect of higher oxygen supply on respiration has not yet been tested.

Table 3. Respiration of *Alnus* Nodules and Roots

Oxygen supplied (per cent)	Mean Q_{O_2} of nodules	Mean Q_{O_2} of roots
21	2·72	1·03
12	1·86	0·80
5	1·14	0·64
1	0·35	0·33

Three samples of nodules or root portions from 2nd-year plants were set up in each oxygen/nitrogen mixture, measurements being continued for four hours, during which time the respiration remained essentially steady. Difference required between means for significance = 0·43 for nodules, 0·08 for roots ($P = 0·05$).

Though comparison of the oxygen effects on fixation and nodular respiration is hindered by the drift in oxygen supply in the fixation experiment, the data show that both processes are markedly and perhaps similarly affected by reduction of oxygen supply. The possibility which thus arises that the two processes are closely linked will be further investigated.

We wish to thank Dr. R. I. Reed for kindly carrying out the mass-spectrometer analyses.

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Secretion of a Highly Sulphated Acid Mucopolysaccharide by the Brittle-star, *Ophiocomina nigra*

The secretion of a mucus from the tube-feet of ophiuroids is well known[1], although the chemical nature of this substance has not been investigated. In a study of the feeding mechanisms of ophiuroids, I find that *Ophiocomina nigra* (Abildgaard), a common littoral species widespread in the north-east Atlantic and Mediterranean, in addition to the mucin of the tube-feet, secretes all over the body surface an abundant mucus used in conjunction with a detritus-feeding mechanism. Attempts to find the source of

this secretion have revealed two types of mucus glands previously undescribed for the species.

(*a*) Large numbers of unicellular glands are distributed over all the general body surface. Histochemically, their secretion gives the general reactions of a simple acid mucopolysaccharide.

(*b*) In addition, there are massive glands within the calcareous structures covering the body, best developed within the lateral arm spines. The mucus within the arm spine is massed along the aboral aspect of a nerve cord which occupies the central longitudinal axis of the spine. These glands open to the exterior along the aboral and lateral surfaces of the spine by means of regularly spaced ducts lined with squamous epithelium. The mucus arises from numerous dense granular areas lying irregularly along the nerve strand. One to several nuclei can be seen in each patch, with no clear cell boundaries separating them. Such multi-nucleated glands have been found within the upper, lower and lateral arm plates, in the tentacle scales, oral shields, oral papillæ, and in the tubercles of the disk, as well as within the arm spines. In every case, a distinct nerve tract is in association with the granular source.

The secretion product of these granular patches when stained with toluidine blue exhibits an intense γ-metachromasia, and gives a weakly positive Millon reaction; it is negative to the periodic acid – Schiff reaction and to sudan black *B* applied to frozen sections. It is stable to incubation in commercial testis hyaluronidase, and to various extraction techniques for ribonucleic acids. It has a methylene blue extinction point below *p*H 0·65, lower than that of the mouse mast cells used as controls.

The tube-foot mucin of this species gives identical histochemical reactions.

These results characterize the mucus in question as a highly sulphated acid mucopolysaccharide, similar in nature to fully substituted heparin. A similar epithelial mucin, 'mactin *A*', has been described from the labial palps, gills and inner mantle surface of the bivalve mollusc, *Spisula solidissima*, extracts of which have a strong blood anti-coagulant action[2]. The jelly coat of sea-urchin eggs is known to contain a highly sulphated acid mucopolysaccharide, allied to the connective tissue mucins[3].

Among other species of British Ophiuroidea examined so far, glands secreting a highly sulphated acid mucopolysaccharide have not been found in *Ophiothrix fragilis* and *Ophiura texturata*. *Amphipholis squamata*, however, has within its arm spines glands which, though somewhat different anatomically, secrete a mucus histochemically identical with that of *O. nigra*. These glands are the subject of a considerable body of recently reviewed literature[4], as they are considered to be the source of the phosphorescence for which the species is noted. The phosphorescence of other ophiuroid species is attributed to similar gland cells known to be intensely basophilic.

A full report of this work will be published elsewhere.

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Cytoplasmic Nodules in the Endosperm of some Cucurbitaceae

Cytoplasmic extensions of definite shape growing into the embryo sac during endosperm development have been termed cytoplasmic nodules or vesicles. They are of two types, nucleated and non-nucleated. Nucleated nodules are reported in *Impatiens roylei*[1], *Isomeris arborea*[2] and *Musa errans*[3], while non-nucleated nodules occur in *Oldenlandia corymbosa*[4], *Pennisetum typhoideum*[5] and *Stackhousia linariaefolia*[6]. Billings[2] has reported the development of the embryo from the nucleated nodules in *Isomeris arborea*. Maheshwari and Sachar (unpublished work) have, however, contradicted this and find that the embryo arises from the egg as in other angiosperms. Farooq[4] has reported in *Oldenlandia corymbosa* that these nodules become detached from the general cytoplasm and ultimately degenerate, but I do not agree with him (see below).

The present investigation shows the occurrence of non-nucleated nodules in *Cyclanthera explodens* Naud., *Herpetospermum caudigerum* Wall., *Sechium edule* S.W. and a hermaphrodite variety of *Luffa acutangula* Roxb. Slides of *Cyclanthera explodens* were passed on to me by Prof. Bahadur Singh, while the material of *Herpetospermum caudigerum* and *Sechium edule* was collected from Darjeeling and that of the hermaphrodite variety of *Luffa acutangula* from the Botanical Gardens, B.R. College, Agra.

The endosperm is free nuclear and—in early stages its cytoplasm with free endosperm nuclei—forms a peripheral lining of the embryo sac, with a central vacuole. As the endosperm grows, a balloon-like bulging with a lining of cytoplasm arises in the micropylar region. More protuberances arise in it from the cytoplasm, forming the base of the later bulge (Figs. 1 and 2). These protuberances acquire definite shape and resemble nodules or vesicles described by the authors mentioned above. They are hollow and non-nucleated like the primary cytoplasmic bulging. Endosperm nuclei advance into the primary bulge, being followed later by the formation of more nodules on it (Fig. 1). Cytoplasmic nodules also arise laterally in the vacuole of the embryo sac. All nodules fuse to fill up the space and finally mix with the general cytoplasm. After the fusion of the nodules has taken place, endosperm nuclei advance into the resulting cytoplasm. Any space left in this cytoplasm is further filled up by the formation of fresh nodules (Fig. 3) and finally the whole of the endosperm becomes cellular. Since

Fig. 1. Longitudinal section of the embryo sac of *Luffa acutangula*; × 300. Fig. 2. Endosperm of *Sechium edule*; × 220. Fig. 3. Embryo sac of *Herpetospermum caudigerum*; × 140. *cn*, cytoplasmic nodules *cv*, central vacuole, and *pcb*, primary cytoplasmic bulge

nodules in Cucurbitaceae show greater chromaticity, belated fusion and ultimate mixing with the general cytoplasm, their detachment, degeneration and disappearance in *Oldenlandia* need confirmation.

I thank Prof. Bahadur Singh for guidance, Prof. P. Maheshwari for kindly going through my slides and Dr. R. L. Paliwal for help. For financial assistance, I thank the Government of India for the grant of a junior research training scholarship.

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Biosystematics of the *Sisymbrium irio* Complex

S. irio Linn. is a polytypic winter annual which grows throughout the Panjab plains. It occurs in diploid, triploid, tetraploid, hexaploid and octoploid races. All these races get considerably modified in response to varying amounts of moisture and sunlight. The phenotypic plasticity has been studied experimentally using the conventional 'water-light' gardens.

The diploid is morphologically uniform and shows seven bivalents. Its artificial autotetraploid shows quadrivalents and does not resemble the natural tetraploid. The latter possesses two ecological races which are markedly different from the diploid. At meiosis it has always fourteen bivalents. It is a genomic alloploid, which is confirmed by the presence of fourteen univalents in its polyhaploid. The triploid is morphologically somewhat akin to diploid but differs in details of leaf shape, flower size and above all in being completely sterile. It is a natural hybrid between diploid and tetraploid. At meiosis it shows seven to eight bivalents plus seven to five univalents. Evidently one of the genoms of the tetraploid is homologous with the diploid. Such plants yield only five to six seeds in strong contrast to the production of several thousand by the parents. Generally these seeds are of hexaploid constitution. The hexaploid is morphologically like the triploid except that it has bigger flowers and long fertile siliquas. At meiosis there are almost always twenty-one bivalents, but at times there are one to two quadrivalents. The octoploid is morphologically somewhat akin to tetraploid. However, it differs from the tetraploid in possessing shorter and thicker stems and fruits and bigger and thicker leaves, flowers and seeds. It shows varying numbers of quadrivalents and bivalents.

Crosses were attempted in all directions, but so far no hybrids except the triploid have either been obtained or seen in Nature. The hexaploid and octoploid have been synthesized. The former is either auto-allo or segmental alloploid, while the latter is auto-alloploid. It is concluded that, in this complex, one of the basic genoms is either the same as that of the diploid or of some form very close to it. The other genom has not been discovered yet.

Identifications carried out at the Forestry Research Institute, Dehra Dun, and Kew Herbariums reveal that all the races are taxonomically under the same species—*S. irio* Linn. Comparison of the various races was very kindly made by Dr. N. Y. Sandwith with the Linnean type material. It has become clear that only the hexaploid race compares very well with the Linnean holotype (Sheet No. 836.35) collected from Spain. These resemble each other in fruit characters, but differ in number of lobes of leaves.

The species has a very wide distribution covering the whole of Europe and extending to the north-western Indian sub-continent. So far it has been possible to study it in Panjab (India) primarily from Amritsar and nearby areas within a radius of approximately fifty miles. For any clear understanding of the variation pattern of the *irio* complex it is imperative to study it from most of the areas of its range.

I would be very grateful to the botanists in the area who are in a position to help me by sending seed samples, if possible accompanied by herbarium sheets giving pertinent information. Furthermore, seed samples of any other species of the genus *Sisymbrium* and allied genera like *Alliaria*, *Arabidopsis*, *Descurainia* and *Eutrema* would also be most welcome.

The details of the investigation involving morphological, cytogenetical, ecological and taxonomical aspects of the problem will be published in due course.

I am indebted to Profs. P. N. Mehra, G. L. Stebbins, jun., R. C. Rollins, K. N. Kaul, Drs. N. Y. Sandwith, W. B. Turrill and Father H. Santapau for their encouragement and valuable help.

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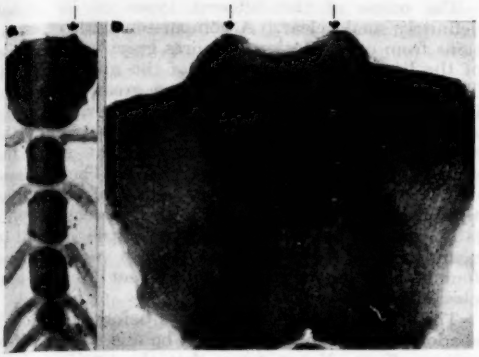
Supra-sternal Ossicles in Primates other than Man: some Isolated Cases in Gorilla and Chimpanzee

Schultz[1] examined nearly three hundred gibbon skeletons and his report contains the following interesting observation: "Separate suprasternal ossicles occur in two of the gibbons examined (= 0·07%). . . . These ossicles are quite common in Man. . . . Never before have they been observed in primates other than man". Cobb[2] found no evidence of suprasternal ossicles in the skeletons of sixty-one gorillas, thirty-eight chimpanzees and eight orangs. Schultz has not seen this primitive condition "among many hundreds of monkey and ape skeletons examined, except in the two gibbons mentioned".

In view of these statements, it is of interest to record that I have found the condition unilaterally, in one chimpanzee, and, bilaterally, in one gorilla out of a total of 101 chimpanzee and 110 gorilla specimens examined. Radiographs of (*a*) the entire chimpanzee sternum and (*b*) the manubrium of the gorilla sternum are shown in Fig. 1. In each case the ossicles were situated towards the posterior margin of the upper border of the manubrium as is always the case in man.

The significance of suprasternal ossicles is still a matter for speculation. The first record of their appearance in man occurs in a paper by Béclard[3], but their discovery was claimed by Breschet[4]. Béclard considered the ossicles to represent rudiments of the furcular clavicle of birds; Breschet believed them to be atavistic remnants of the ventral ends of cervical ribs; Gegenbaur[5], Ruge[6] and Eggeling[7] were of the opinion that they were derived from the



(*a*) (*b*)

Fig. 1. Suprasternal ossicles are indicated by arrows: (*a*) specimen from a juvenile female chimpanzee; (*b*) specimen from an adult male gorilla

primitive episternum; Rambaud and Renault[8], Götte[9] and Dawson[10] derived them from the clavicle; Carwardine[11] from the precoracoid; Anthony[12] regarded them as sesamoids. Finally, after an extensive study, Cobb[2] expresses the view that the suprasternal ossicles are rudiments of the epicoracoids of the primitive shoulder girdle.

The specimens concerned are in the Birchington Collection of anthropoid skeletons. I am indebted to Prof. S. Zuckerman for permission to study this material.

G. T. Ashley

Department of Anatomy,
University,
Manchester 13.
May 6.

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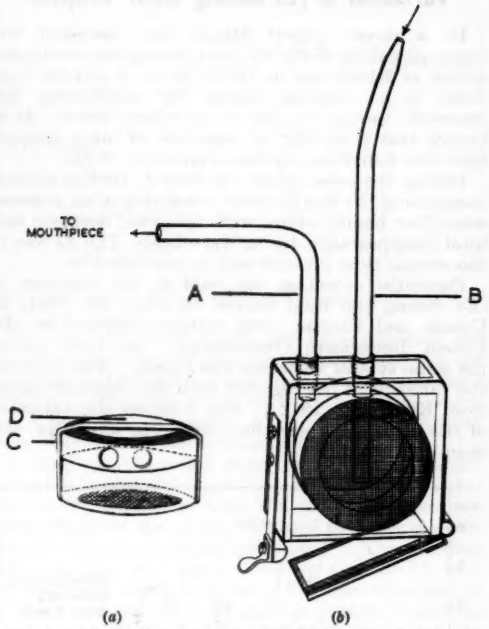
A Combined Aspirator and Feeding Cage for the Collection and Testing of Insects as Vectors of Plant Viruses

This apparatus (Fig. 1*b*) has been designed to minimize the handling of insects during their collection and transfer from plant to plant in virus-transmission tests. It combines the principles of Kunkel's[1] aspirator for the collection of insects and Maramorosch's[2] leaf-feeding cage, so that insects can be sucked direct into the feeding cages.

The aspirator consists of a 'Perspex' box 2½ in. × 2½ in. × 2½ in. with side walls ⅛ in. thick, and base and top ¼ in. thick. Joints are cemented with chloroform. The hinged base has an ¼-in. flange, fitted with a 'Sorbo' rubber seal which is air-tight when closed by the spring clip. Two ¼-in. glass tubes are fitted in the top, using rubber sleeves to make an airtight union. One tube (*A*), projecting slightly into the box, is bent at right angles and connected by



(*a*) (*b*)

Fig. 1. (*a*) Insect-vector cage. (*b*) Combined aspirator and insect-vector cage

rubber tubing to a mouthpiece. The second or inlet tube (*B*) projects 2 in. into the box and is drawn into an ¼-in. jet at the outer end.

The cage (Fig. 1*a*) is made from a commercially manufactured polystyrene pill-box, 2 in. × 1 in., with a tight-fitting lid. Holes 1½ in. in diameter are cut in the lid and base of the box and covered with 34-mesh nylon gauze, which is cemented in position with a solution of the plastic in chloroform. Matching ¼-in. holes are cut in the sides of the box and the lid. On the opposite side of the box a small hole is made through which a string-wick is fitted (not shown in Figs. 1*a* or 1*b*).

The cage is inserted in the aspirator so that the intake tube passes through the matching holes in the lid and side of the cage. Insects are drawn through the jet and into the cage by sucking air through the aspirator. The cage is then withdrawn, the inlet hole closed by twisting the lid, and another cage inserted.

In feeding tests, the cage is clipped on to the leaf with a 2-in. × ¼-in. rubber band (*C*). The disks (*D*), which were cut from the pill-boxes, can be used to press the surface against the nylon gauze through which the insects feed. The cage is orientated so that the string-wick is at the lowest point, and absorbs the honey-dew.

When several species of insects have been collected into one cage, they can be separated most conveniently by replacing the cage in the aspirator and anæsthetizing the insects with carbon dioxide passed in through the inlet tube.

J. T. Legg

East Malling Research Station,
Maidstone, Kent.
May 9.

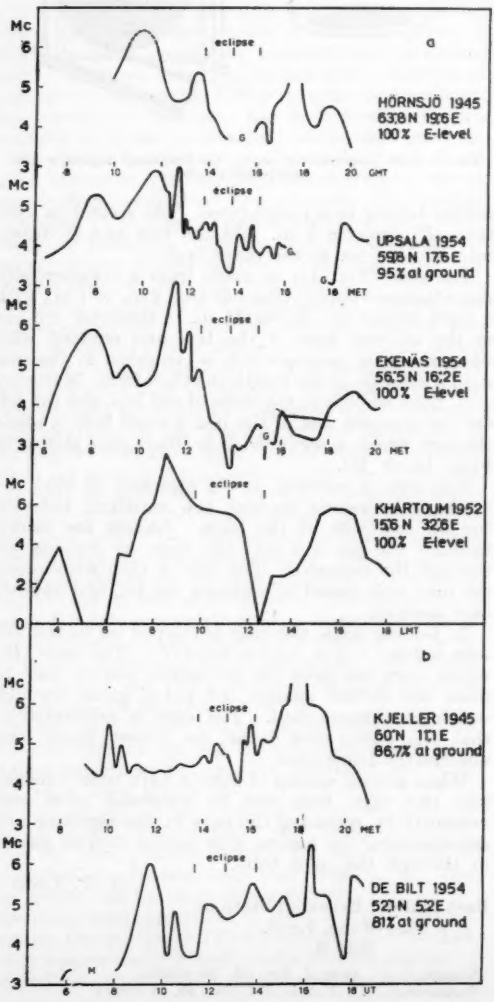
[1] Kunkel, L. O., *Amer. J. Bot.*, **13**, 646 (1926).
[2] Maramorosch, K., *J. N.Y. Ent. Soc.*, **59**, 49 (1951).

Variation of *fEs* during Solar Eclipses

In a recent paper[1] Minnis has discussed the observed values of the *Es* layer during the total solar eclipse at Khartoum in 1952. He is of opinion that there is no obvious reason for attributing the observed decrease in *fEs* to an eclipse effect. It is known that a number of observers of other eclipses have not found any typical variations of *fEs*.

During the total eclipse on July 9, 1945, a typical variation of *fEs* was noticed[2], consisting of an increase some four hours before, with following decrease and total disappearance during the eclipse. The *Es* was of the special type present only in summer-time.

Particular attention was paid to the variation of *fEs* during the total eclipse on June 30, 1954, at Upsala and Ekenäs, both stations operated by the Upsala Ionosphere Observatory. At both places the same typical variation was found. Fig. *a* shows the variation of *fEs* together with the observed values from Khartoum, 1952[1]. Fig. *b* shows the variation of *fEs* at places where the eclipse was somewhat less than 100 per cent.



The origin of the different types of *Es* is not definitely made clear. A comparison with observations from other stations requires great care because of the limitations in accuracy of the measurements. The median values of *fEs* from a great number of ionosphere observatories show, however, that the effect of the radiation from the sun is one of the agents producing *Es*. This is evident from the diurnal and seasonal variations of *fEs*. The decrease of *fEs* simultaneously with the course of the eclipse thus seems quite reasonable. The decrease of *fEs* is only found at places where the eclipse is total or nearly total. It seems that no eclipse variations are found at places with less than about 75 per cent obscuration.

The increase of *fEs* some hours before the moon's shadow strikes the earth cannot be due to any direct eclipse effect. Yet it seems that the typical eclipse configuration of sun–moon–earth is responsible in some manner for producing this effect.

W. Stoffregen

Upsala Ionosphere Observatory,
Upsala 10. April 29.

[1] Minnis, C. M., *J. Atmo. Terr. Phys.*, **6**, 91 (1955).
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Dielectric Strength of Organic Liquids

Work in this laboratory on the conductivity of hexane at high steady fields has shown that measurements can be made at field-strengths far in excess of those previously reported. For gaps of 25 and 150 microns, it was possible to measure the conductivity up to stresses of 1,500 kV./cm. and 1,150 kV./cm. respectively.

This can be achieved by eliminating the pulses occurring at high fields which prevent current measurements. Spectroscopically pure hexane was used, and it was further dried and slowly distilled in a closed system under a reduced pressure to obtain a moisture- and dust-free liquid. The electrodes were polished so that no scratches were visible when they were viewed under an optical microscope, and they were finally cleaned with hexane. Even with this treatment, some current pulses occurred, and it was essential to keep these to a small amplitude because of the ensuing deterioration of the electrodes and the liquid and to reduce the risk of a spurious breakdown.

By keeping the applied voltage only slightly in excess of the onset voltage of the pulses, it was possible to control and eliminate them by a conditioning process. For this purpose a high resistance was connected in series with the test cell and the test voltage was increased only after the pulses had subsided. To facilitate the observation of the pulses, a high-gain pulse amplifier together with a cathode-ray oscillograph was used. A high-speed electronic diverter (operating time $\simeq 0{\cdot}7$ μsec.) safeguarded the electrometer and prevented spurious breakdown damage during conditioning.

As a rule, numerous pulses of appreciable magnitude were observed in a field region of 300–400 kV./cm., but beyond this the pulses were small except near the breakdown field, where very severe isolated pulses were likely to occur. Very pure liquids were relatively easy to condition, and a liquid showing no detectable pulses at high fields could be obtained; but for less pure liquids it was not often possible to reach the higher fields. The immediate breakdown region was indicated by the rapid rise in the steady current and

by the further isolated current pulses which began to occur. In practice, the liquid was conditioned up to 100 kV./cm. or so beyond the maximum stress used during the measurements.

A series of conductivity curves for several gap-distances in the range 300–50 μ have been obtained. These tests show that:

(i) Once conditioning has been carried out for one polarity, no further conditioning is necessary for measurements of the other polarity.

(ii) For symmetrical electrodes with a spacing of about 75 μ there is no polarity effect, and identical conductivity graphs were obtained for stresses up to 1,150 kV./cm.

(iii) For electrodes of different metals, the conductivity curve depends on the nature of the cathode; for example, using chromium and silver for the electrodes, the current for 1,000 kV./cm. was 2½ times greater when silver was the cathode.

(iv) With proper conditioning the consistency of the results was very noticeable, provided the test electrodes remained in the closed system during the tests. In a long test the initial curves could be reproduced at the end of the test; but the purity conditions appeared to be so exacting that slightly different curves were obtained after a rest period of 12 hr.

The impression has been gained that the conductivity may be largely determined by adsorbed layers on the electrodes and hence depends upon the state of purity of the liquid; the two would be expected to be related, and a dynamical equilibrium would be established between them.

It is intended to publish a more detailed account of this work elsewhere.

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High Voltage Laboratory,
Queen Mary College,
London, E.1. May 6.

A New Thermal Method for Sound Absorption in Liquids

After establishing[1] the equivalence of sonic and thermal energies (given by the relation $I = JH$, where I is the intensity of sound at the source, H is the heat produced by absorption of this sound and J the conversion factor which has the same value of $4{\cdot}19 \times 10^7$ ergs/sec. as the mechanical equivalent of heat) this relationship was utilized in this Laboratory to develop a novel technique for the measurement of ultrasonic absorption coefficient in liquids. It consists of the measurement of heat produced at different points along the path of an ultrasonic beam, and its application in the formula $H = H_0 \exp(-2\alpha x)$ where I in the usual formula for attenuation is replaced by H because of the earlier equivalence relation. A series of measurements of absorption coefficient have been taken with this technique and the results have already been reported[2] elsewhere along with full experimental details. These results have shown that the accuracy of this method is high and the values of absorption coefficient so obtained are in close agreement with those obtained by other methods of measurement.

Recently, Dutta and Samal[3] have reported in *Nature* measurements of absorption coefficients using the same principle. According to them, the absorption coefficients of benzene and carbon disulphide are 75×10^{-17} cm.$^{-1}$ sec.^{2} and 115×10^{-17} cm.$^{-1}$ sec.^{2} respectively, as against the values obtained by others which are about 800×10^{-17} cm.$^{-1}$ sec.^{2} and $7{,}500 \times 10^{-17}$ cm.$^{-1}$ sec.^{2}.

Table 1

No.	Liquid	Observed $a/\nu^2 \times 10^{17}$ cm.$^{-1}$ sec.^{2} at 28° C.	Previous results $a/\nu^2 \times 10^{17}$ cm.$^{-1}$ sec.^{2}	References
	1	2	3	4
1	Benzene	816	900 at 20°–25° 906 ,, 30° 812 ,, 30°	4 5 2
2	*m*-Xylene	89	80 ,, 27° 76 ,, 30°	6 and 7 5
3	*n*-Propyl alcohol	84	77 ,, 26° 75 ,, 22°–28°	8 9
4	*n*-Propyl acetate	138	145 ,, 30°	5

To check on these results we have repeated our experiments at about 5 Mc./sec., utilizing our thermal technique. The results obtained are given in column 3 of Table 1. For comparison, results of earlier measurements are given in column 4. It may be seen from these values that the reproducibility is good.

It may also be noted that these results compare well with values obtained by other methods in this Laboratory, as well as with the commonly accepted values based on the results obtained by other workers using a variety of refined techniques[4–9]. Our thermal technique has also been used by Grossetti[10], who reports good results in water. For our experiments by this technique we have used a generator capable of delivering 10 watts radio-frequency power but set to a low output to prevent the crystal from giving rise to violent ripples in the liquid. It has been observed that, with correct matching, only a small amount of electrical power is needed for the work. Again, the sound energy is completely absorbed in the cell containing a long column of highly absorbing liquid and no correction is required to be made for sound energy leaving the system. This feature also gives rise to more heat, with the result that the accuracy of measurement is comparatively high in this method.

As against this, the results obtained by Dutta and Samal are in complete disagreement with those obtained by us by the above technique and confirmed by us here, as also with other results by workers using different methods. The deviation is obviously due to some flaws in the method and in interpretation of observations. A detailed paper on this work will be published elsewhere.

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M. Pancholy
C. B. Tipnis

National Physical Laboratory of India,
New Delhi 12.
June 14.

[1] Parthasarathy, S., Chari, S. S., and Srinivasan, D., *Ann. d. Phys.*, **12**, 8 (1953); *J. Acoust. Soc. Amer.*, **25**, 335 (1953). See *Nature*, **173**, 110 (1954).

[2] Parthasarathy, S., Chari, S. S., and Mahendroo, P. P., *Z. Naturforschung*, **8a**, 273 (1953); *J. de Phys. et le Rad.*, **14**, 366 (1953). Parthasarathy, S., and Mahendroo, P. P., *Il Nuovo Cimento*, **10**, 1196 (1953). Parthasarathy, S., Mahendroo, P. P., and Mathur, S. S., *J. Sci. Indust. Res.*, **12B**, 457 (1953).

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[7] Pinkerton, J. M. M., *Proc. Phys. Soc.*, **62B**, 129 (1949).

[8] Parthasarathy, S., Tipnis, C. B., and Pancholy, M., *Z. Phys.* (In the press).

[9] Pellam, J. R., and Galt, K. J., *J. Chem. Phys.*, **14**, 608 (1946).

[10] Grossetti, E., *Il Nuovo Cimento*, **11**, 250 (1954).

FORTHCOMING EVENTS

Wednesday, September 28

Physical Society, Colour Group (in the Small Physics Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 3.30 p.m. —Prof. W. D. Wright: "A Report on International Discussions on Colour, 1955: The C.I.E. Meeting, Zurich; the Colour Congress, Heidelberg; the F.A.T.I.P.E.C. Congress, Spa".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. G. I. Hitchcox: "Extending the Limits of Resistance Measurement Using Electronic Techniques".

Wednesday, September 28—Friday, September 30

National Smoke Abatement Society (in the Grand Hall, Town Hall, Bournemouth)—Twenty-second Annual Conference.

Thursday, September 29—Friday, September 30

Institute of Physics, Stress Analysis Group (at Stephenson Hall, The University, Sheffield)—Ninth Annual Conference.

Saturday, October 1

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 9.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemists (with a first- or second-class honours degree and preferably with some postgraduate research experience), at the North Thames Gas Board, Chemical By-Products Works, Beckton, East Ham, London, E.6, for research on problems in connexion with coal tar distillation, and the manufacture of phenols, naphthalene and bases—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting 666/288 (September 30).

Curator (with a university degree in engineering and/or naval architecture or equivalent qualification) of Shipbuilding and Engineering—Town Clerk, City Chambers, Glasgow (September 30).

Lecturer or Assistant Lecturer in General and Physical Chemistry—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (September 30).

Physical Chemists (with good honours degree), for work covering both fundamental and applied research on coal—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting SS/63 (October 5).

Scientific Officer (with first- or second-class honours degree in physics, mechanical or chemical engineering or equivalent qualification) at the Ministry of Supply Research and Development Establishment, Waltham Abbey, to assist in research on heat transfer phenomena at high temperatures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.329/5A (October 8).

Assistant Mathematical Statistician (with a degree in statistics or science or mathematics which has included a statistics course), to assist in the design and analysis of laboratory and small-scale plant experiments—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting SS/70 (October 12).

Chair of Physical Chemistry at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 12).

Chair of Physics at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 18).

Chair of Geology at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 24).

Assistant Lecturer or Lecturer (with a degree in agriculture or science) in Entomology, at Canterbury Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Education at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Medicine at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Surgery at the University of Sydney—Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Lecturer or Senior Lecturer in Dental Biochemistry at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

Senior Lecturer or Lecturer (preferably with experience in the design and construction of hydraulic works and apparatus) in Civil Engineering at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Senior Lecturer in the Department of Metallurgy and Assaying at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 31).

Assistant Lecturer in the Department of Economics—The Registrar, The University, Liverpool (November 1).

Biochemist (with experience in the chemistry of proteins), for a laboratory engaged in work on human plasma—Secretary, Lister Institute of Preventive Medicine, Elstree, Herts.

Fuel Technologist (graduate in fuel technology, chemical or mechanical engineering, physics or chemistry, and preferably with experience of high temperature furnaces) in the Fuel Technology Section, to work on problems involving fuel utilization and heat transfer in the iron and steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting F.T.1.

Lecturers (3) (with a degree in engineering or science, lecturing experience and specialist knowledge of either electrical engineering, electronics or servo-mechanisms) at the R.E.M.E. Training Centre, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.422/5A.

Microbiologist (with first- or second-class honours degree and at least three years postgraduate research experience in bacteriology or allied fields), for basic research on taxonomy and biochemistry of marine bacteria—The Superintendent, Torry Research Station, Aberdeen.

Physicists and Electrical Engineers, Scientific Officer or Experimental Officer grades (with first- or second-class honours degree or H.S.C. (science) or equivalent qualifications) at the Armament Research and Development Establishment, near Sevenoaks, Kent, for research and development work on weapon systems and in particular fuse techniques, also experimental design, development and operation of physical measuring apparatus—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.335/5A.

Pleistocene Geologist (with first- or second-class honours degree in geology and postgraduate experience in sedimentary geology of the Tertiary and Quaternary formations, and special interest in geomorphology and stone age cultures) in the Geological Survey Department, Uganda, to undertake field mapping with special reference to the Plio-Pleistocene rocks of Uganda, including lacustrine and alluvial deposits and their associated physiographical features—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/9/05.

Production Chemists (with honours degree in chemistry or chemical engineering or A.R.I.C. or A.M.I.Chem.E. or equivalent qualifications), for Royal Ordnance Factories in South-West Scotland, Pembrokeshire and Somerset, to assist in technical control or administration for explosives and acids manufacture, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.696/5A.

Scientific Officer (with first- or second-class honours degree in mechanical engineering, physics or chemistry or equivalent qualification) at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, to apply results of research to development of personal and collective defensive equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.336/5A.

Senior Experimental Officer (with at least H.S.C. (science) or equivalent; a degree in physics or electrical engineering an advantage) in the General Physics Division, to carry out research and development work in the field of high speed frame and streak photography—Establishment Officer, United Kingdom Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/395.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Forestry Commission. Bulletin No. 21: Tree Root Development on Upland Heaths. By C. W. Yeatman. Pp. iv+72+24 plates and diagrams. 10*s.* 6*d.* net. Leaflet No. 34: Badgers in Woodlands. Pp. 10. 9*d.* net. Leaflet No. 35: Pine Sawflies. Pp. 8. 9*d.* net. (London: H.M. Stationery Office, 1955.) [6]

World Power Conference. Annual Report, 1954. Pp. 17. (London: World Power Conference, 1955.) [6]

Reporting Back: a Report of the Groups of Young Managers attending the Universities of Cincinnati and Syracuse under the auspices of the Mutual Security Agency, 1951–1953. Pp. vii+60. (London: Management Publications, Ltd., 1955.) 7*s.* 6*d.* [6]

Association of British Chemical Manufacturers. Notes on Work Study. No. 1: How to Start. Pp. v+9. 2*s.* 6*d.* No. 2: Some Results. Pp. v+14. 2*s.* 6*d.* (London: Association of British Chemical Manufacturers, 1955.) [6]

Kent Incorporated Society for Promoting Experiments in Horticulture. East Malling Research Station. Annual Report, 1954. (Forty-second year, 1st October, 1953 to 30th September, 1954.) (A.38.) Pp. 170+34 plates. (East Malling: East Malling Research Station, 1955.) 12*s.* 6*d.* net; 2 dollars. [6]

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